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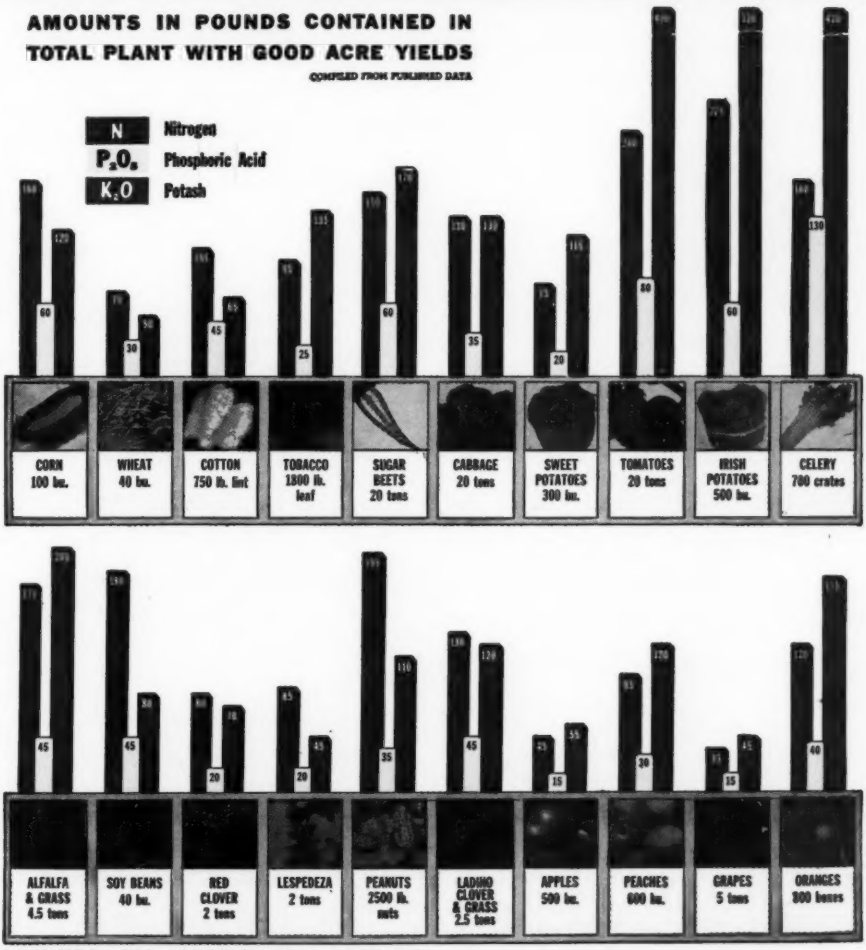

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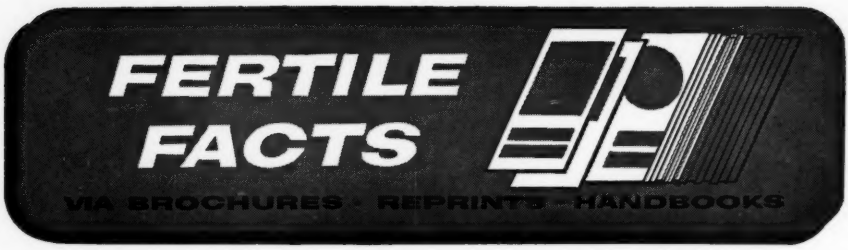

The following article reprints on profitable soil and crop management are available on request. Please indicate the reprint code and the number you desire. The address is: American Potash Institute, 1102 16th Street, N. W., Washington 6, D. C.

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A-1-52	Research Points the Way to Higher Levels of Peanut Production
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U-4-54	Nutrient Balance Affects Corn Yield and Stalk Strength
LL-10-54	Relation of Fertilizer to Quality and Yield of Flue-cured Tobacco
C-1-55	Summary of Ten Years' Work with Complete Fertilizers on Sugar Cane

VEGETABLE CROPS

SS-12-49	Fertilizing Vegetable Crops
SS-11-54	Foliar Application of Plant Nutrients to Vegetable Crops

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P-3-45	Balanced Fertility in the Orchard
BB-8-50	Trends in Soil Management of Peach Orchards
X-8-51	Orchard Fertilization Ground and Foliage
EE-8-54	Red Apples Require Balanced Nutrition
J-4-56	The Relation of Potassium to Fruit Size in Oranges
X-10-57	Diagnosing Fruit Needs

SOILS AND FERTILIZER—GENERAL

3-1-56	Potash in Agriculture
A-1-44	What's in That Fertilizer Bag?
TT-11-47	How Different Plant Nutrients Influence Plant Growth
JJ-11-53	Boron—Important to Crops
R-3-54	Soil Fertility (Basis for High Crop Production)
YY-12-54	Physical Condition of the Soil Affects Fertilizer Utilization
D-1-55	Nitrogen Use Accentuates Need for Minerals
U-10-57	Fall Fertilizing Pays Off
V-10-57	Salts of the Earth

GENERAL

S-5-40	What Is the Matter with Your Soil?
Y-5-46	Learn Hunger Signs of Crops
GG-10-48	Starved Plants Show Their Hunger
BB-10-51	Healthy Plants Must Be Well Nourished
KK-12-51	Potassium in Animal Nutrition
CC-6-54	Fertility Increases Efficiency of Soil Moisture
A-1-55	Potash-Deficiency Symptoms

ON THE COVER . . .

. . . we bring an American Potash Institute chart up to date, giving a composite picture of the nitrogen (N), phosphoric acid (P_2O_5), and potash (K_2O) contained in good yields of 20 important crops.

The amount of nutrients our crops take from the soil today is important—more important than ever before—because we are having to depend on less and less soil to feed more and more people.

And, with the present price-cost squeeze what it is, more and more farmers are learning how important it is to know approximately how much plant food their various crops need—if they are to produce the kind of yields that bring real profits. That means quality as well as quantity.

In his article, starting on page 8, J. D. Romaine of Washington, D. C. considers plant food content of our major crops.

Through the chart on the cover and a table in the article, we see that such crops as celery, potatoes, tomatoes, and sugar beets contain large amounts of plant foods—and that oranges, sweet potatoes, tobacco, cabbage, peaches, and corn also use healthy quantities of plant food.

"Most of these crops are rather intensively grown, and it is not particularly surprising that they feed heavily upon the soil," Agronomist Romaine explains.

But what is "rather startling," he points out, are the large amounts of plant foods removed from the soil by the legume crops such as alfalfa, lespedeza, soybeans, red clover, and peanuts.

Excepting peanuts, these legume crops are known as soil-building crops. But, obviously, unless turned under as green manures they are anything but soil building—in fact, very soil depleting.

When used for hay or pastured by livestock, they drain heavily on the minerals in the soil, such as phosphoric acid and potash.

These and other facts on plant food content are discussed in this month's cover article. And large 16 x 22-inch color posters of the cover are now available for display on request.

Better Crops with PLANT FOOD

The Whole Truth
Not Selected Truth

SANTFORD MARTIN, *Editor*

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CONTENTS FOR THIS ISSUE

Rescue the Obscure 3
By Jeff McDermid

When Fertilizing Consider Plant Food Content of Your Crops 8
By J. D. Romaine

How to Grow Alfalfa-Orchardgrass Mixture 16
By R. D. Sears and R. E. Blaser

Are We Losing Another Race to the Russians? 24
By E. T. York, Jr.

Mint Grown on Organic Soils 28
By J. F. Davis, R. E. Lucas, and L. N. Shepherd

Southern Alluvial Plain 39
By H. B. Vanderford

The Milkman

Better Crops with PLANT FOOD

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Folksy notes and documents

RESCUE THE OBSCURE

Jeff McDermid

(Elwood R. McIntyre)

No one is obscure from the All-Seeing Eye, the Good Book says. With local and family archives available, many careers cast in remote places amid solitude, danger and sorrow are well preserved.

Were it not for a few memoirs, county histories, and tattered packets of letters and diaries, we would have little but hand-me-down tales to guide us in our search for ancestral annals. Yet with what we have to go on, we are able to keep the proper balance between the publicized leaders of the past and humble trail-blazers in their cabins in the clearings.

Few books or scenarios lift our isolated forebears to public acclaim. Few streets or towns or rivers bear their names. No huge bronze statues, green with verdigris and spattered with messy bird lime, prance forward to do them honor on pedestals of renown.

Few such sculptured monuments glorify the maternal spirit of the pioneers—those home-contriving ladies.

I have pored over notes left by my grandma as faded words on the Testament fly leaves. My hunger for further human documents was happily provided by a friend whose family haunted libraries and courthouse vaults for original records to fulfill the pleasant task of verifying and certifying pedigrees.

From this, a brief outline of a life spent in relative obscurity comes forth—a life worthy of a testimonial of immortality.

Ruhama Nickles Bilderback Green—a long name of long ago, including two trips to the Ohio frontier, capture by the Senecas, two marriages, and a large "passel" of descending kinfolk.

It all began 170 years ago. Capt. Charles Bilderback came west across the Shenandoah with Ruhama his bride to start farming on the east side of the Ohio river below Wheeling. Both were Virginians. He was a survivor of Col. Crawford's awful defeat by British and Indians on the Upper Sandusky.

They pastured some of their cattle on the west shore. On this June day, Charles and Ruhama paddled their canoe across the Ohio to inspect the herd. They left their 3-year-old boy and infant girl in charge of younger brother, Jacob Bilderback. To Ruhama, a ride across the placid river would be restful and diverting she thought. But it was anything but.

Hardly had the couple beached the canoe and pushed through the willows to look for their cattle when piercing war whoops and pounding feet spoke terror and doom. Ruhama gathered up her skirts and crouched behind a mossy driftwood heap. But the Captain, recognized by the Senecas as a killer of long-standing, was quickly seized and bound fast with osier withes.

Hoping to appease the fury of the red men, he shouted loudly for his

"NOT HALTED BY GRISLY MEMORIES . . .

wife to surrender. It was a bitter, dubious choice, but after a backward glance toward home, Ruhama gallantly came out. She was taken westward by one band of Senecas, her frantic husband pushed forward by another. After separating for a few days, the two bands met again for a last bloody denouement on the banks of the Tuscaroras.

Ruhama hoped to find her husband. In vain she scanned the circle of iron-faced warriors. From the rear of the savages came a relentless young brave, waving a pole topped with a ruddy scalp lock. Picking it off, the heartless savage threw the horrid proof of lingering death straight into the lap of the anguished widow, dirty and stained with the hurried travel. Exhausted, she let the awful trophy lie, and soon fell into a heavy slumber. When she awoke it was gone.

On reaching their village near the Miami, the tribe adopted Ruhama to be a drudge and servant for the squaws. She endured the sickening, filthy food and customs of Indian domestic life for 9 months. She prepared meat, cut and sewed shirts and leggings, hauled water and learned quill and bead work and the art of preserving hides and skins.

The Ft. Washington Garrison at Wheeling was told of the woman's capture and whereabouts by some friendly Indians. In a few months, she was ransomed by the troops at Ft. Harrison, Cincinnati. Quickly gaining her strength and courage, Ruhama returned for a time to her cabin on the east shore. She found Jacob, her husband's brother, had taken good care of her little ones. In a few weeks, she joined a wagon train on the national road and settled her young family in her native Jefferson county, Virginia.

Not halted by grisly memories or disgust at raw adventures, Ruhama soon chose another Virginia partner for a second pioneer pilgrimage back to the wild Ohio country. In 1798, the newly-wed Greens and the two Bilderback children pitched camp in the Hockhocking valley, three miles from Lancaster, Ohio. Here John Green died in 1831, while Ruhama lived in a thrift and household stewardship until September 1842, when she died at 72 years and 11 months. The Greens had 3 sons, 5 daughters.

Records from Ruhama Green's last will were found in the Fairfield county court house. Her will and the legal details involved, even more than the danger-filled days of her life, give insight into the painstaking love of detail concerning the ordinary items of personal pride left in pathetic devotion to her survivors.

Residue of the estate, after debts and funeral expenses, she willed thus: All movable property to be sold at auction, with proceeds to her four living daughters; and the 50 acres of homestead likewise to be put on sale, the net income to be divided between her 10 grandchildren. Thus directed, she signed in peaceful resignation "in the name of God, Amen; I being in perfect health of body and of sound and disposing mind."

Net proceeds from the sale of personal goods in late November, 1842, by Auctioneer Leonard for a fee of $3, amounted to $269.59. Two sessions of "public vendue and outcry" were needed, however, because not

. . . OR DISGUST AT RAW ADVENTURES"

enough security was offered the first time to cover all bids. From the land sale, a balance of $741 was derived.

Among the debts presented and paid were $10 for a coffin, $5 for a headstone, $9.90 in justice fees, $7 for clerical costs, executor's fee, $26, and county tax, $6.96. Most of the articles put on the block bore appraised values fixed beforehand by a group of friendly neighbors. Ruhama's children living in the county bid in as much as they could.

Just note some of the odds and ends of a long pastoral life, held up by the auctioneer, and the final figure when his hammer fell. (Half-cent coins were then in vogue).

A bureau desk, $7.06½; one walnut bed and bedding, $22; one large copper kettle, $10; leghorn bonnet and box, 50 cents; one mantel clock, $8.50; one grey horse, $32; one bay mare, $40; two muley cows, $14; 86 bushels of corn, 14 cents each, $12.04; one hay stack, $7.37½; six silver tablespoons, $8.10½; rolling pin, tea canister, stone pickle jar, red petticoat and needle case, 3½ cents each.

Her library was meager, as most of the wilderness workers possessed. But somebody in the family circle secured the old volumes to keep the well of memory flowing. They paid 62 cents for "Thompson's Narrative," one dollar for a military biography, 96 cents for a "book of marters," 12½ cents for a hymn book, and one dollar for the family Bible.

No stout-hearted ancestor of goodwill and firm belief in America remains wholly obscure. The more we get to know about their brave endeavors and resistance to despair, the more our faith will kindle about *our nation's orbit in the paths of truth and through the galaxy of time.*◄◄◄

REVIEWS

December, 1957

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When fertilizing

Consider Plant Food Content Of Your Crops

Growth like this doesn't just happen. It takes plenty of plant food in the soil.

By J. D. Romaine
Washington, D. C.

THE plant foods contained in crops have been investigated more or less systematically by agricultural chemists for many years.

Interest in having the results of these investigations compiled for ready reference has increased markedly in recent years. This was first due in part to government soil conservation programs stressing the importance of maintaining and improving the fertility of our soils.

Crops also have been classified as soil building and soil depleting, giving rise to the question of whether plant food content of the crop has a bearing on this classification.

In more recent years, plant breeders have provided farmers with new varieties of crops capable of producing much greater yields. These higher yields, of course, made correspondingly greater demands on the plant nutrients in the soil. Unless these greater requirements are met by natural soil fertility or fertilizer or manure additions, farmers cannot take full advantage of the high producing capacity of these new varieties.

Reduced yield and quality of crops, and the widespread increase in abnormalities and diseases of crops that have been identified as nutrient deficiency symptoms, also are bringing home to farmers the fact that the soils of North America are becoming depleted of their fertility. It is becoming apparent that fertilizers will have to be applied to soils once thought to be inexhaustibly fertile, if our farmers are to maintain satisfactory crop yield and quality. When considering the reasons for this depletion, and the use of fertilizers on the various plants grown, the amounts of plant foods contained in crops have been frequently questioned.

To supply this information, data

Legumes, like this alfalfa, are called soil-building crops because they can fix nitrogen from the air. But, they deplete the soil badly when not turned under or not fed the phosphate and potash they need.

from numerous sources have been compiled to give the nitrogen (N), phosphoric acid (P_2O_5), and potash (K_2O) contained in good yields of important representative crops, (Table I). The figures give amounts in the entire plant, and where of practical importance, in the harvested and any unharvested part of the crop. Total figures do not include roots unless they are harvested.

Legume Removals Startling

From the table, note that crops of celery, potatoes, tomatoes, and sugar beets all contain high amounts of plant foods. Oranges, sweet potatoes, tobacco, cabbage, peaches, and corn also use considerable quantities. Most of these crops are rather intensively grown, and it is not particularly surprising that they feed heavily upon the soil.

Rather startling, however, are the large removals by the legume crops such as alfalfa, lespedeza, soy beans, red clover, and peanuts. With the exception of peanuts, these are known as soil-conserving or soil-building crops. It is obvious that unless these crops are turned under as green manures they are *by no means soil building, but highly soil depleting.* When they are cut for hay or pastured, there is a heavy drain on the minerals in the soil, such as phosphoric acid and potash. The nitrogen in the crops comes mostly from the air, and so is not a loss when the crop is harvested. Even when the crops are turned un-

der, the soil is enriched only in organic matter and nitrogen, since the phosphoric acid and potash come from the soil and are merely being returned to it unless the crop was fertilized with these nutrients.

Practical demonstration of potash depletion by legumes when they are removed from the soil is seen in a publication of the Alabama Experiment Station. It reported that when peanuts are grown in the rotation, more potash must be used on cotton. The increased amount of cotton rust, *which is really potash starvation,* following legumes also indicates these crops deplete the potash in the soil.

This does not mean that legumes are not good crops to grow, or that they are unduly hard on the soil. Properly handled and fertilized, they are very beneficial, giving high quality feed and improving the nitrogen and organic matter or humus supply of the soil. Their value is shown by the fact that when they are grown in the rotation, *and proper amounts of phosphate and potash applied to them and other crops,* the yields of *all crops* in the rotation will be higher than if the legumes are not grown.

Plant-food Removal

Breaking down the data into the parts of the plant permits using the table to determine total nutrients needed and the nutrients removed from the soil when the crop is harvested. When practically the entire crop is harvested and removed from the soil, there is no need to break down the figures.

When discussing data of this nature, some prefer to consider only the nutrients removed from the soil in the harvested crop. While this is important, it is equally important to know *how much of the nutrients must be available to the crop* if a good yield is to be obtained.

For example, a 100 bushel crop of corn removes about 150 pounds of the three main nutrients in the grain and cobs, but 190 pounds is contained in the stover, and this must be available to the crop if a full yield is to be obtained. The same applies in varying proportions to many other crops.

Moreover, the nutrients contained in the whole plant frequently are removed from the field, and these figures represent removal from the soil so far as the next crop is concerned. The straw, tops, and other parts of the plant not considered as a principal part of the crop may be returned to the soil as manure later in the rotation, but the following crop does not have the nutrients contained therein for its use.

Cases have been noted where, under actual field conditions, the available nutrients in the soil following a crop of poorly fertilized wheat were reduced *to practically nothing.* The nutrients in the straw, in part at least, would be returned to the field in the manure later in the rotation, but the hay crop immediately following the wheat suffered greatly *from a lack of potash.* In the case of many vegetable crops, the tops or vines may be removed from the soil and largely lost. Care should be taken to keep these losses as low as possible, but they are almost sure to occur to some extent.

Considering the individual nutrient content, it will be observed that in general, the nitrogen and potash are much higher than the phosphoric acid.

Irish potatoes, tomatoes, and the legumes are the highest in nitrogen. Celery is the highest potash-using crop, followed by tomatoes, Irish potatoes, alfalfa, and oranges.

Celery, tomatoes, corn, sugar beets, and Irish potatoes use the most phosphoric acid.

The division of the nutrients within the parts of the crop or plant shows that nitrogen and phosphoric acid tend to be high *in the seed parts* while potash is high in the *stalk parts or roots.* Some exceptions to these gen-

TABLE I—NUTRIENT CONTENT OF CROPS

Crop	Yield	Part of Crop	N lbs.	P_2O_5 lbs.	K_2O lbs.	Total
Cotton	750 lbs.	lint				
	1,250 lbs.	seed	60	30	20	110
	2,000 lbs.	burrs, leaves and stalks	45	15	45	105
	Total		105	45	65	215
Tobacco	1,800 lbs.	leaves	65	13	95	173
		stalks	30	12	40	82
	Total		95	25	135	255
Corn	100 bu.	grain	90	35	25	150
	3 tons	stover	70	25	95	190
	Total		160	60	120	340
Wheat	40 bu.	grain	50	25	15	90
	1.5 tons	straw	20	5	35	60
	Total		70	30	50	150
Oats	80 bu.	grain	50	20	15	85
	2.0 tons	straw	25	15	80	120
	Total		75	35	95	205
Barley	65 bu.	grain	57	26	19	102
	1.5 tons	straw	17	6	44	67
	Total		74	32	63	169
Potatoes	500 bu.	tubers	100	40	190	330
		vines	125	20	140	285
	Total		225	60	330	615
Sweet Potatoes	300 bu.	roots	45	15	75	135
		vines	30	5	40	75
	Total		75	20	115	210
Sugar Beets	20 tons	roots	75	30	70	175
		tops	75	30	100	205
	Total		150	60	170	380
Tomatoes	20 tons	fruit	120	40	160	320
		vines	80	40	240	360
	Total		200	80	400	680
Muskmelon	7 tons	fruit	30	11	60	101
	1.5 tons	vines	20	4	30	54
	Total		50	15	90	155
Cabbage	20 tons	all	130	35	130	295
Celery	700 crates (60 lb.)	all	160	130	470	760
Spinach	9 tons	all	90	30	45	165
	1,000 bu.					
Apples	500 bu.	fruit	30	10	45	85
		leaves and wood	15	5	10	30
	Total		45	15	55	115
Peaches	600 bu.	fruit	35	20	65	120
		leaves and wood	60	10	55	125
	Total		95	30	120	245
Grapes	5 tons	fruit	15	10	25	50
		leaves and wood	20	5	20	45
	Total		35	15	45	95

Continued on Page 12

Crop	Yield	Part of Crop	N lbs.	P_2O_5 lbs.	K_2O lbs.	Total
Oranges	800 boxes	fruit	85	30	140	255
		leaves and wood	35	10	35	80
	Total		120	40	175	335
Soy Beans	40 bu.	grain	150	35	55	240
		straw	30	10	25	65
	Total		180	45	80	305
Peanuts	2,500 lbs.	nuts	90	10	15	115
	4,500 lbs.	vines	105	25	95	225
	Total		195	35	110	340
Pea Beans	30 bu.	grain	73	23	24	120
		straw	22	7	31	60
	Total		95	30	55	180
Alfalfa	4 tons	hay	180	40	180	400
Sweet Clover	5 tons	all	185	45	165	395
Red Clover	2 tons	all	80	20	70	170
Ladino Clover	2 tons	all	130	30	120	280
Lespedeza	2 tons	all	85	20	40	140
Cow Peas	2 tons	all	125	25	90	240
Timothy	2 tons	all	55	20	60	135

eralities will be seen, especially in soy beans.

Practical application of these figures is very important in fertilizer usage. It is common knowledge among farmers that different crops growing on the same soil must be fertilized differently for best results. There are a number of reasons for this—the principal agronomic ones being variation in *plant food content of the plants* and in the *feeding power of the plant for the nutrients in the soil.* The value of the crop also is an important factor, but cannot be given more than general consideration in this article.

If only the nutrients contained in the crop had to be given consideration in determining the fertilizer to use, the matter would be comparatively simple. The problem is more complicated than this, but the following few generalities based on observation and experience, coupled with the information given in plant food content tables, can help you develop a fertilizer program that is more efficient and profitable.

Plant Food Sources

In the case of nitrogen, the organic matter in the soil is a possible source of this nutrient for all plants. In addition, legumes, by means of the nodule organisms on their roots, can obtain the greater part of their nitrogen from the air. Therefore legumes usually require little or no nitrogen in fertilizer form except for enough to start the plant when grown on soils of low fertility or low in organic matter. The nitrogen figures for legumes thus cannot be considered as a guide to the nitrogen fertilizer needs of these crops. So far as the other crops are concerned, the nitrogen figures are important in showing the relative needs of the crops for this nutrient. The chief uncertain factors here are the amount of organic matter in the soil and the extent to which the crop can draw on the nitrogen in it.

The phosphoric acid for the crop, for all practical purposes, comes entirely from the soil supply or fertilizer and manure additions. The figures for this nutrient, however, probably have the least significance so far as determining fertilizer application is concerned. This is due to a large part of the phosphoric acid applied to soils reacting with materials in the soil in such a way that it is "fixed" or absorbed and then is only very slowly

available to the plant. Thus, the amount of phosphoric acid applied must be large enough to take care of the soil's "fixing-power" and then leave some over for the plant.

Placement of fertilizer such as in bands in the soil and control of fertilizer particle size such as granulation are used to help meet this problem. Liming helps the situation somewhat. On light sandy soils, fixation usually is much less than on heavy soils, and the use of comparatively large amounts of phosphoric acid over a period of years gradually fills the soil's hunger for phosphate, so that on sandy soils or on soils well fertilized with phosphate in the past, the phosphoric acid needed in the fertilizer tends to approach that given in the table. On the newer soils, and especially on heavy soils, relatively larger amounts of phosphoric acid must be used.

The natural soil supply, and additions in fertilizer or manure, also are the sources of potash for the crop. Since most of the potash in the soil is unavailable to plants, no attention need be paid to the total potash content of the soil so far as fertilizing any one crop is concerned. The available potash content of the soil is of great importance to the crop. If it is low, compared to the amount needed by the crop, more potash must be applied for optimum yield and quality of crop.

Sandy soils are usually low in potash. The heavy soils are frequently better supplied with this nutrient, but removal of potash by cropping without sufficient replacement by fertilizer and manure causes depletion of the available potash even in those soils naturally well supplied. On some heavy soils, "fixation" or absorption renders potash unavailable to the immediate crop. This apparently is more common on heavy soils subject to alternate wetting and drying. And as with phosphoric acid, enough potash must be applied to take care of the soil's "fixing" power and leave some over for the crop. This condition, however, is not as common in the case of potash as for phosphate.

Cotton rust (left) is potash starvation. The cotton (right) received enough potash for vigorous growth.

Band placement of fertilizer may help overcome the problem. Peat and muck soils usually are very low in potash and require high potash applications, approaching the figures given in the table for good crop growth.

Trend Toward Higher Analysis

Thus, in the table, the figures for the nitrogen in the non-leguminous crops, and those for potash in all the crops, are the most important and significant from the fertilizer standpoint. *However, the longer soils are farmed and the lighter the soil, the more fertilizer usage tends to approach*

Grain crops—like this wheat—take large amounts of nutrients from the soil.

the figures given for all three nutrients. This is exemplified in trends in fertilizer usage in various parts of North America.

On soils in the East, which have been farmed longer and which along the coastal regions frequently are sandier, fertilizers commonly used are in a 1:2:2 or 1:1:1 ratio, while formerly they had a wider ratio, especially with respect to phosphoric acid.

On newer soils in the West, fertilizer ratios of 1:8:1 and 1:6:1 were common. With the longer farming of these soils, the fertilizer usage ratio is *changing rapidly to 1:2:1, 1:4:4, 1:2:2.*

In sections of Europe, where agriculture is still older than in any place in this country, fertilizer usage is commonly based entirely on the plant foods contained in the crop, with allowance made only for the nutrients contained in manure applied.

Figures on the nutrients contained in the crops as a whole and in the various parts of the plants can be used directly in determining how much plant food is removed from the soil with various yields. Higher or lower yields will remove nutrients roughly in proportion to the variation in yield from that stated in the table.

The data also show the importance of conserving as carefully as possible crop residues, straw, and other parts of the crop frequently not considered of much importance. When properly used, they have a high fertilizing value, and when wasted, represent a direct loss to the farmer.

When compiling the data for the table, numerous sources were consulted, a list of which is given at the end of the article. The excellent figures of Van Slyke were used more than any other single source, but they have been supplemented with those of various other authorities. Mr. E. K. Weathers kindly supplied information which permitted the calculation of nutrient contents of lespedeza on a pounds per acre basis, and Mr. F. E. Gladwin and Dr. A. Ulrich supplied additional data on grape analyses from their personal files. Dr. W. L. Nelson supplied data on high levels of yields and Dr. E. T. York, Jr. on peanuts.

So far as possible, the data have been taken for crops growing under representative conditions of climate, rainfall, and fertility. All of these factors influence markedly the nutrient content of the plant. Numerous data show the variation that may occur when crops are grown with high or low levels of fertility.

For the present, those fertility levels which give the optimum yields are considered most appropriate and therefore representative of the nutrient conditions under which the plant should be grown. ◄◄◄

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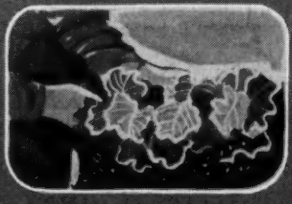

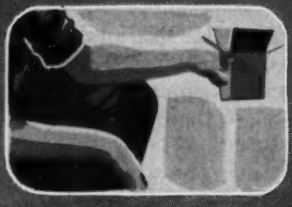

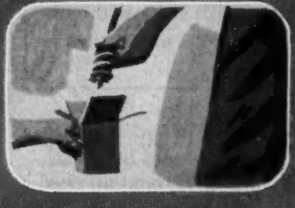

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How To Grow Alfalfa-Orchardgrass Mixture

WITH PHOSPHOROUS & POTASSIUM

JUST a generation ago, most farm income in Southern Piedmont Virginia came from tobacco.

Today, the picture here has become diversified through beef and dairy cattle. And the people are seeking more and more facts on growing pasture, silage, and hay crops—because feed constitutes nearly 50 per cent of dairy cattle production costs and 75 per cent of beef cattle costs.

Adaptation of Alfalfa

Alfalfa can now be used by farmers in areas where it has not been an important crop, because varieties have been developed to resist stem and leaf diseases which commonly occur in warmer humid regions.

Alfalfa varieties that recover quickly after mowing, such as Williamsburg, are aggressive toward troublesome weeds like crabgrass. It can be grown alone or in grass mixtures and used for silage, hay, and grazing.

Many farmers are learning to use alfalfa with grass as a suitable crop for controlling bloat while grazing. When grazing alfalfa-grass mixtures, the farmers use short grazing periods of about one week, followed by a resting period, until their alfalfa reaches a bud or early blooming stage of growth. This is important.

When the farmer uses adequate lime with phosphorus, potassium, and borax on well-drained soils, alfalfa is one of the easiest legumes to establish. The seedlings grow very fast when seeded in late summer, but spring seedings are also successful. Alfalfa or alfalfa-grass mixtures, grown on adapted soils and cut and fertilized properly, have been more productive than any other grass-legume mixture.

Likewise, alfalfa has produced more per acre in Virginia than grasses such as Kentucky 31 fescue, orchardgrass, or Coastal bermuda with liberal nitrogen fertilization.

Dr. R. E. Blaser, a native of Nebraska, is Professor of Agronomy, Pasture and Forage Crops Research at VPI. He earned his B.S. from the University of Nebraska, M.S. from Rutgers, Ph.D. from N. C. State. He has specialized in "the physiological and ecological factors associated with adaptation and utilizing forage plants."

"When the farmer uses adequate lime with phosphorus, potassium, and borax on well-drained soils, alfalfa is one of the easiest legumes to establish. Alfalfa or alfalfa-grass mixtures, grown on adapted soils and cut and fertilized properly, have been more productive than any other grass-legume mixture."

By R. D. Sears
and
R. E. Blaser

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Virginia
Agricultural Experiment Station

Fertilizer Experiment

An experiment to study the yield and survival of alfalfa, when fertilized with different amounts of phosphorus and potassium, was set up at the Southside Virginia Research Station at Charlotte Court House on an eroded Cecil sandy loam soil, both acid and low in fertility.

The soil tests showed medium availability of phosphorus. Potassium and lime were low. The soil was limed to pH 6.7 and borax was applied annually at the rate of 15 pounds per acre.

Although good alfalfa stands are usually easy to get, the first seeding made in 1950 was not uniform enough for an experiment, so the soil was disked and reseeded in the spring of 1951. All the plots were seeded with 15 pounds of inoculated alfalfa seed mixed with 6 pounds of Virginia commercial orchardgrass per acre. The hay crop was harvested 4 times each season—the first crop before alfalfa

Mr. R. D. Sears, a native Virginian who earned his B.S. from VPI, heads research at the Southside Virginia Research Station. He is assistant agronomist with the Virginia Agricultural Experiment Station, specializing in varietal, fertility, and management research with corn, small grains, forage, pasture crops, and dark fire cured tobacco.

BORON

Boron is known to be necessary for satisfactory production and longevity of alfalfa stands, according to R. E. Blaser, of the Virginia Agricultural Experiment Station.

An experiment was started in 1954, at the Northern Virginia Pasture Research Station at Middleburg, *to study the response of several legumes grown alone and in mixtures to boron applications in terms of yield and botanical composition of the stands.*

In March, 1954, twelve mixtures of legumes and grasses were seeded in 6 x 10 plots on a Chester loam soil known to be deficient in boron. One thousand pounds of a 2-12-12 fertilizer were disced into the seedbed and topdressings of 500 lbs. of 0-14-14 applied each fall after the first year. Thirty pounds of borax were applied annually to half of each plot while the other half received no boron. The experiment was laid out in five replications of a split-plot design.

Alfalfa, when supplied with boron and grown alone, yielded 25% and 17% more forage in 1955 and 1956, respectively, than alfalfa from which boron was withheld. The percentage of alfalfa in the harvest was also higher in 1956, (1955 data were not available); 84% alfalfa when boron was supplied, and 56% when boron was withheld.

When supplied with boron, stands of birdsfoot trefoil yielded 22% more forage in 1955 and 33% more forage in 1956, than when boron was withheld. The percentage of trefoil in the harvest in 1956 was 3% when boron was withheld and 26% when boron was supplied.

Alfalfa-bluegrass stands which received boron produced 33% and 44% more forage in 1955 and 1956, respectively, than those which did not receive boron. The percentage of alfalfa in the harvest in 1956 was also higher; 71% in the borated plots and 52% in the non-borated plots.

Table I.—The Yield of an Alfalfa-Orchardgrass Mixture and Soil Analyses as Influenced by Rate of Applying Potash as Late Winter Applications

K_2O applied yearly in Feb.	Dry matter-lbs./acre			Soil analyses Dec. 1955	
	1955	1956	Average 1952-56	K_2O in lbs./acre	pH
0 lbs.	2413	1350	2794 lbs. of hay	61	7.0
50 lbs. (1)	4940	2727	4360 lbs. of hay	97	6.8
100 lbs.	6055	3805	5254 lbs. of hay	95	7.0
200 lbs.	6832	5240	6298 lbs. of hay	160	7.0
400 lbs.	8085	6096	7124 lbs. of hay	314	7.2

(1) 50 pounds of K_2O are equal to 83 pounds of muriate of potash with 60% K_2O.

bloomed (when orchardgrass was heading) and the next three crops when alfalfa was about in one tenth bloom.

Potash Fertilization

The potassium treatments, shown in tables I and II were applied on small plots repeated 4 times. The hay yields given in the tables are average values for these 4 replicated plots. To save space, hay yields are given for 1955, 1956, and for the 5-year average, 1952-1956.

The treatments, pictured in Table I, show the hay yields when different amounts of K_2O were applied in one application in the spring. The 5-year average yield was 2794 pounds of oven dry hay per acre when potassium was not applied.

The K_2O applications and hay yields were as follows: 50 pounds of K_2O, *4360 pounds of hay;* 100 pounds of K_2O, *5254 pounds of hay;* 200 pounds K_2O, *6298 pounds of hay;* and 400 pounds of K_2O per acre produced *7124 pounds of hay per acre.*[1]

The hay without K_2O fertilizer was largely grass, the stand of alfalfa very poor.

When 50 pounds of potash were applied per acre, less than half of the hay was alfalfa and the survival and growth of alfalfa was very poor.

When 200 pounds or more of K_2O were applied annually per acre, over 70 per cent of the hay was alfalfa, the remainder orchardgrass.

In this sixth year for harvesting the plots, the stand and growth of alfalfa are still very satisfactory and weed-free *where plenty of potash was used.*

Since boron, lime, and phosphorus were all liberally applied, it is apparent long-lived, productive alfalfa stands were associated with potassium fertilization. The most practical rate of applying potassium for these soil conditions is around 200 pounds of K_2O, when applied in the spring in one application.

Late winter fertilization of potassium was not the most efficient method of application for this acid soil. Table II shows the hay yields when potash was applied at different seasons and as split applications. Notice the average yield for the five years was 6298 pounds of hay per acre when 200 pounds of K_2O were applied *in February* as contrasted with 7202 pounds of hay when 200 pounds of K_2O were applied *after the first hay crop was harvested.*

The yield was 6849 pounds of hay when the same amount of potash was applied in two applications—100 pounds K_2O in February and the same amount after the second hay crop.

With 100-pound rates of K_2O, the per acre yield amounted to 5254

Table II.—The Yield of an Alfalfa-Orchardgrass Mixture as Influenced by Date of Applying Potash

Rate and method of applying potash	Dry matter-lbs./acre			Soil analyses	
	1955	1956	Average 1952-56	K_2O in lbs./acre	pH
200 lbs. in Feb.	6832	5240	6298	173	6.8
200 lbs. after first hay cut	8056	6050	7202	167	6.8
200 lbs.—100 in Feb. and 100 lbs. after 2nd. hay cut	7107	5933	6849	143	6.8
100 lbs. in Feb.	6055	3805	5254	95	7.0
100 lbs. after first cut	7074	4537	6220	105	6.8

pounds of hay when all of the potash was applied in spring as compared with 6220 pounds of hay per acre when the K_2O was applied after the first hay harvest. Notice 100 pounds of K_2O applied *after the first hay cut* produced about the same amount of hay as 200 pounds *applied in February.*

This means, apparently, that some of the unavailable potassium in certain clay minerals of Cecil and other soils is made available during the winter season. The effects of weathering (alternate freezing and thawing) combined with chemical and biological reactions, modern science believes, release unavailable potassium to a chemically available source.

If made available during the winter months, potassium fertilizers may be used more efficiently by applying K_2O *after the first hay cut* or *as a split application where some of the potash is applied during the summer.* Potassium from muriate of potash (60% K_2O) is readily absorbed by plants.

When liberal amounts of K_2O are applied in one late winter application, plants absorb more potassium than they need for normal growth and high yields. This high absorption in the first hay crop leaves a limited amount of K_2O in the soil for growth in mid and late season.

We now know grass-legume mixtures require *more potassium* than legumes grown alone. The grasses of northern origin—such as Kentucky 31 fescue, orchardgrass, and others—absorb *more potassium* than legumes do even though grasses require less potassium than legumes. So, we can expect alfalfa-grass mixtures to yield better than pure alfalfa to split applications or late season fertilization with potash.

After five productive years of growing alfalfa, the soil tests show pH values ranging from 6.8 to 7.2. Lime has not been applied since 1950, when the pH was 6.7. These pH values indicate that lime had not fully reacted with the soil when the experiment was established. The high pH values may be contributing to the longevity and production of the alfalfa.

The soil analyses show that potassium was very low where K_2O was not applied. When less than 100 pounds of K_2O were applied per acre, the potassium in the soil at the end of the season was too low to produce high alfalfa yields. Generally, the amount of potassium in the soil showed a fair association with the amount applied.

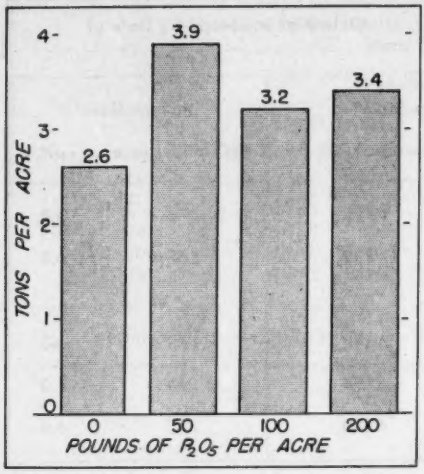

Fig. 1.

Phosphorus Fertilization

Lime, boron, and potassium were applied liberally and uniformly to study the influence of phosphorus on alfalfa-grass yields and stands—to compare annual applications of phosphorus with heavy, infrequent applications.

Fig. 1 shows the yield of an alfalfa orchardgrass mixture, when fertilized with different amounts of P_2O_5 annually. The hay yields amounted to 5269 pounds per acre without phosphorus as compared with yields ranging from 6368 to 6849 pounds per acre when P_2O_5 was applied annually. The yields for 200 pounds of P_2O_5 per acre annually were no higher than the yields for 50 pounds of P_2O_5 annually.

Since surface applications of phosphorus fertilizers become fixed near the soil surface on the heavier textured soils, large applications of phosphorus were worked into the soil to compare with annual treatments on the surface, Table III. When 400 pounds of P_2O_5 (equivalent to one ton of 20% superphosphate) were worked into the surface four inches of soil before alfalfa was established, 5996 pounds of hay per acre were produced annually. When 200 pounds of P_2O_5 were put into the soil before sowing alfalfa, 6060 pounds of hay per acre were produced for a 5-year period, without additional phosphate.

The hay yields of an alfalfa-orchardgrass mixture were increased by annual topdressings of phosphorus, even though heavy applications of P_2O_5 were used before sowing. Phosphate fertilizer treatments may be compared where 200 pounds of P_2O_5 were incorporated into the soil at the time the experiment was started with treatments where additional amounts of P_2O_5 at O, 50, 100 and 200 pounds per acre were applied annually.

The yield increases from annual P_2O_5 fertilization were not large, but there were consistent increases with increased P_2O_5 applications for the period 1952-1956, Table III.

The hay yields, when incorporating 100 pounds of P_2O_5 initially followed with 50 pounds as compared with 100 pounds of P_2O_5 annually, were similar. The results suggest that the most practical rate of phosphate on this soil is 50 pounds of P_2O_5 for establishment and this same amount annually.

Even on this eroded soil, thought to be low in fertility, the heavy initial applications of P_2O_5 followed with annual topdressings produced no higher hay yields than the treatment with 50 pounds of P_2O_5 applied annually. In general, a 3-ton hay yield usually removes about 35 pounds of P_2O_5 per acre annually.

The soil tests for phosphorus, as given in Table III, were soil samples from the surface three inches of soil. For this reason, the phosphate analyses are much higher than they would normally be if the samples had been taken to a plow depth. Remember, all of the P_2O_5 applications, except those made before seeding, were applied on the soil surface. Note the soil test showed 36 pounds of P_2O_5 on the plots *where phosphate fertilizers had not been made.*

The soil test showed 69 pounds of P_2O_5 where 400 pounds of P_2O_5 fer-

Table III.—The Yield of an Alfalfa-Orchardgrass Mixture and Soil Analysis as Influenced by the Amount of P_2O_5 Used for Establishment and Maintenance.

P_2O_5 applied per acre		Dry matter-lbs./acre			Soil analyses, Dec., 1955	
Before seeding	Yearly in February	1955	1956	1952-1956	P_2O_5-lbs./acre	pH
Heavy Applications Without Annual Fertilization						
0	0	5569	3666	5269	36	7.0
400	0	6545	4707	5996	69	6.8
200	0	6425	4437	6060	52	6.9
Heavy to Light Applications for Establishing with Different Rates for Maintenance						
200	0	6425	4437	6060	52	6.9
200	50	7174	5258	6497	100	6.8
200	100	7007	5615	6683	193	6.8
200	200	7107	5933	6849	422	6.8
100	50	7314	5469	6483	100	6.9
100	100	6926	5385	6368	229	6.9

tilizer were applied before seeding. On the plots that received 200 pounds of P_2O_5 initially, the soil test showed 52 pounds of available phosphorus as compared with 422 pounds of P_2O_5, where 200 pounds of P_2O_5 were applied annually.

There is a good relationship between the soil tests and the amount of phosphate fertilizer applied annually. The soil tests also indicate that 50 pounds of P_2O_5 applied per acre per year are entirely adequate. There was a decided build-up in soil phosphorus when 50 pounds of P_2O_5 were applied annually per acre; the soil being about 3 times as high in phosphorus when compared with plots where phosphate had not been applied.

The soil pH values, ranging from 6.8 to 7.0, were considered very favorable for alfalfa. A liming program to obtain a pH of 6.8 seems to create a very favorable environment for alfalfa, increasing the efficiency of phosphorus and potassium utilization.

[1] 50 pounds of K_2O is equal to 83 pounds of muriate of potash with 60% of K_2O. ◀◀◀

OUT-MODED APPLICATOR

In spite of the trend towards higher analysis and also higher rates of fertilizer, many still use the same application equipment today as in 1949—namely the split boot. With low analysis fertilizers and at slow planting speeds, the split boot was fairly satisfactory.

However, just where the split-boot applicator will place the fertilizer depends on the speed of planting and compactness of the seedbed. With today's high speed planting, the fertilizer tends to be drawn in close to the seed. With compact seedbeds, the fertilizer may be deposited very close to or on the soil surface.

Split-boot placement has and will give good returns from small to moderate applications of fertilizer. However, those who still use the split-boot attachment should plant at slow speeds and plan to supplement their small "starter" applications with broadcast fertilizer.

FOR BETTER SOILS

FERTILEGRAMS

Minnesota farmers are using more fertilizer than ever, but there is still a lot of state cropland which is going hungry for plant food.

There was about 15 percent more fertilizer used during the 1957 crop season over a year earlier, according to W. P. Martin, head of the University of Minnesota soils department and R. E. Bergman, State Feed and Fertilizer Control office.

Total fertilizer use so far this year is about a half million tons in Minnesota.

But Martin points out that plant nutrient use is still outrunning fertilizer application. Only half of the farmers in the Gopher state use any commercial fertilizer at all. And most of what they do use goes on corn.

One bright spot in the fertilizer picture is a steady trend toward "higher analysis" fertilizer, Martin says. This means farmers are getting more for their fertilizer dollars than ever. Total plant food now makes up more than 40 percent of all fertilizer sold, compared to only 27 percent 10 years ago.

Martin attributes the upward trend in fertilizer use to increasing awareness by farmers that fertilizer is one of their best guards against the price-cost squeeze. Prices for fertilizer have risen only six percent in the past 10 years, compared to 40 percent for land and machinery, 28 percent for wages and building supplies and 56 percent for farm real estate taxes.

Also, Martin explains that fertilizer increases production efficiency. Fertilizer often returns as much as $3-5 in increased crop value for every dollar of fertilizer cost.

Increases in soil tests have also helped boost fertilizer use. Martin says the University soil testing laboratory handled 20,000 samples in 1956 and has tested even more than that so far this year.

The 1957 yearbook of agriculture features information gained by the United States Soil Survey, a cooperative venture of the Department of Agriculture and state experiment stations, according to a recent release by the USDA, publishers of the volume.

Title of the 1957 edition is "Soil."

A congressional document, the yearbook of agriculture is distributed by members of Congress. Copies aren't available from the USDA but can be obtained for $2.25 from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

The yearbook notes that the soil survey has accumulated an enormous amount of data and promoted a better understanding of the nation's soils. However, it also points out that much of the work of mapping soils by types is still ahead.

An attractive yard is just as important to the looks of a home as a good paint job.

But unfortunately, the frame around the house doesn't just come naturally—especially for Alabamians—says Auburn Polytechnic Institute Agronomist J. C. Lowery.

Home owners in most parts of the state, he says, must go to extra lengths to place carpets of green around their houses. Successful lawns require proper fertilization. And it's important that lime requirements are met.

One lawn's fertilizer needs may differ from those of neighboring yards, said the specialist. That's why it's so important for a home owner to know what materials are right for his place.

It's possible for grass growers to take the guesswork out of lime, phosphate, and potash requirements on their lawns, declared Lowery, by having soil tests made at the Auburn soil-testing laboratory. These tests, to let growers know exact materials and amounts to use on their plants, are also a boon to shrubbery and flower growers and to home gardeners.

Any county agent can give growers instructions and necessary supplies for getting their soils tested. And he'll point

FROM ACROSS THE LAND

FOR BETTER CROPS

out exact procedures and explain fully how tests can benefit growers.

Lowery urged lawn-conscious home owners and other gardeners to have their soils tested as soon as possible. Getting the job done right away will make it possible to get the results before cold weather hits in Alabama.

The laboratory is kept pretty busy during February and March by farmers geting fields tested for coming cotton and corn plantings, Lowery said. So home owners can get quicker service if they send their samples before the rush starts.

The efficient use of lime is an important consideration when planning crops to be seeded in the spring, according to Joseph N. Matthews, assistant agronomist, University of Tennessee Agricultural Extension Service.

In Tennessee, lime is used largely to neutralize soil acids. Although plants vary widely in their tolerance to acidity, a suitable pH range for most crops grown in Tennessee is from 6.0 to 6.5. This generally means that applications of lime are necessary on most farms if high production is to be secured and maintained.

It takes lime approximately two to four months to correct the acid condition of the soil; therefore it should be applied at least that far in advance of spring seeding.

Lime applied to plowed land and mixed thoroughly with the soil is preferred. This allows for maximum contact with the soil particles and a quicker correction of the acid condition of the soil.

The amount of lime needed per acre varies widely depending on the past history of the land and the crop to be grown. The best way to determine the amount of lime to apply is through the use of a soil test. Matthews says.

The amount of plant food removed from the soil by a crop is one index, but not the only one, to the amount of fertilizer to apply, according to W. W. Moschler, assistant agronomist at VPI Agricultural Experiment Station.

He says the amount of fertilizer farmers are advised to use is the amount which has produced the highest yields at the least cost in carefully controlled tests. The amount of fertilizer actually contained in the hay when it is cut is not always closely related to the amount applied.

Scientists gain interesting and useful information from analysis of crops, Moschler explains. Much research is aimed at finding:

Why all the elements contained in fertilizer cannot be absorbed by plants?

What new fertilizer compounds might be easier to absorb?

What are the soil properties that influence the solubility of the fertilizer?

And, are plants alike in their ability to use fertilizer?

Plant scientists have analyzed all the important crop plants.

The Virginia station has just finished a report which shows the fertilizer elements contained per ton of hay in each of 11 cuttings of alfalfa over a three-year period. About 100 pounds of nitrogen, 15 pounds of phosphate, and 50 pounds of potash were found in each ton of cured hay.

The amount of phosphorus contained in a ton of hay was practically the same regardless of how much phosphate fertilizer was applied. The percentage of phosphorus in the plant is relatively stable and does not vary over a very wide range. The plant seems to say that this much phosphorus is needed for healthy growth —not much more and not much less. The only effect of applying too little phosphate fertilizer is a smaller yield.

The potassium content of the hay varied widely, depending on how much was available to the plant from the soil or from the fertilizer applied. The potassium in the hay ranged from 30 to 60 pounds per ton, with an average of about 50.

Are We Losing A
To The Rus

'. . . in an age when Rus ia, the total number o coll is graduating 2½ tim s *tural students than e U*

By E. T. York, Jr.

ARE we losing *another* race to the Russians, this time over a different but potentially more significant "Sputnik" — agricultural technology?

Recent reports indicate the Russians are in the process of launching a rocket of improved agricultural technology that could have a greater impact upon the struggle for world freedom than earth satellites and intercontinental missiles.

Two facts strongly indicate the trend this race has taken in the past decade:

(1) Russia is graduating 2½ times more agricultural students today than the United States, with only half the total number of college students. In 1954, over 10% of Russia's college graduates were in agriculture, while 2.2% of our students were agricultural specialists.

(2) The number of students graduating from Soviet agricultural colleges *increased almost 80%* in just six years—1948 to 1954—while the number of students graduating from U. S. agricultural colleges *declined more than 30%.*

If "Sputnik I" didn't dispel any doubts about the quality and effectiveness of Russian scientific training, here are a few facts that should:

• *Under a compulsory curriculum, all Russian students are introduced to biology in the fourth grade; geometry, algebra, and physics in the sixth grade; chemistry in the seventh; and calculus in the tenth.*

• *Upon graduation from secondary school, the Russian student has completed five years of physics and four years of chemistry,* while most of our high schools require neither of these courses.

• *The Russians require five years of mathematics, above the arithmetic level, and ve*
ology, while we u ally one.

• *The Russian tude to a higher level ma* high school *than ost cultural* college tude *quired to know.*

It is well recognized of the progress th ha in agricultural tech no country has res d f plication of the fundam physical and biologic For example, the se physics, and micro iolo velopment of so d soil management, and mathematics, bota y, in the developme t of —illustrate how re our knowledge of he to improve agricu ure

Recognizing these Soviets are going ll o their agricultural tud

ng Another Race
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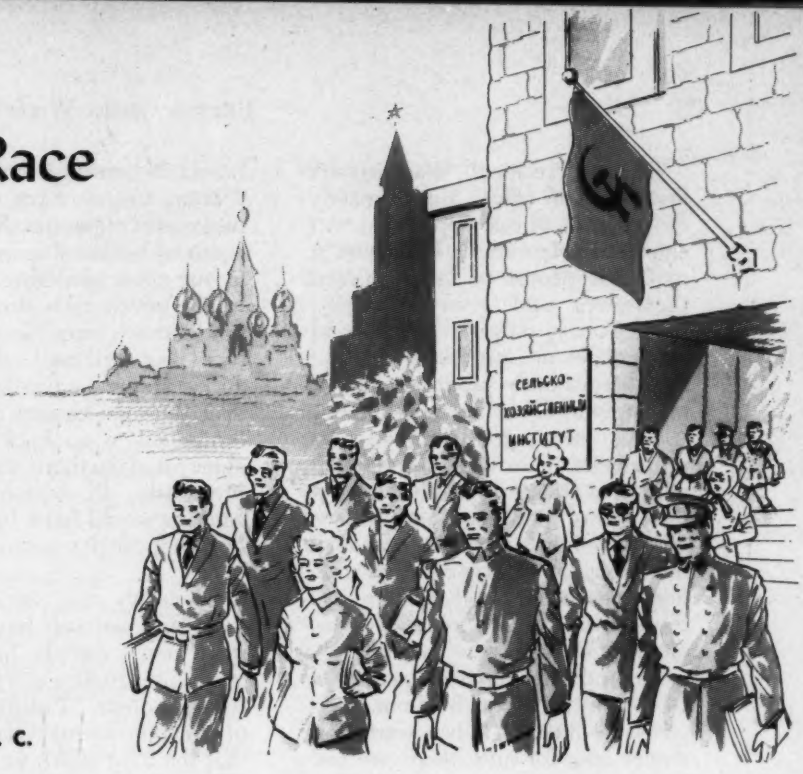

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Washington, D. C.

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fundamental sciences. With this type of training being offered the great mass of students now passing through Soviet agricultural colleges, there is little reason why the Russians should not be able to do well in any race for superiority in agricultural science.

The Russians are also using every available opportunity to take advantage of existing agricultural know-how from the United States and other sections of the world. Here are examples of their efforts:

- *They employ corps of language experts to translate reports of scientific work in agriculture from around the world. The United States has no such program—meaning significant foreign scientific developments may go unnoticed for years by us, but seldom by the Russians.*

- *Since World War II, the Russians have secured from us thousands of bushels of hybrid seed corn and high-yielding, disease-resistant wheat, eggs from superior strains of poultry, an entire herd of Santa Gertrudis cattle (the only breed which the United States can claim to have developed), as well as a wide variety of other improved plant and animal germ plasm.*

By taking advantage of many of our most significant advances in agricultural technology, they have the opportunity to progress at a much faster rate than we were able to in the past without the benefits of such advance work. They should catch up in a hurry unless we, at the same time, intensify our efforts.

Some would say "so what"—what difference does it make if the Russians are able to equal our achievements in agriculture? The answer to such a question is best provided by examining the contributions which recent developments in agricultural science have made here in the United States.

Continued on page 26

During President Washington's first term of office, approximately 90 per cent of our population was engaged in farming. Therefore, it took nine people on farms to feed themselves and one extra person. Today, only 12 per cent of our people are on farms so that each farm family produces enough to supply itself and seven others.

Thus, through continued improvements in our agricultural technology, we have been able to produce more per acre and reduce manpower requirements through mechanization. Consequently, millions who would have had to farm to survive are free to build automobiles, TV sets, new homes, highways, and other conveniences.

As long as so much of our energies were directed only toward producing food for subsistence, we had little opportunity to industrialize and make the many improvements that we take for granted today. Therefore, at the very foundation of the development of our high standard of living—the highest of any country on the earth—has been our increased capacity to produce needed agricultural commodities.

Not only are we the best fed nation on earth, we are also the cheapest fed in terms of our earning capacity. Improved agricultural technology is largely responsible for this. Dr. Byron T. Shaw, Administrator, Agricultural Research Service of the U. S. Department of Agriculture, estimated that if farmers farmed in 1950 as they did just ten years previously, in 1940, the American housewife would have to pay ten billion dollars more each year for food.

In the United States today, it takes an average return from about six minutes of labor to buy a loaf of bread; in Russia it takes 14 minutes; 32 minutes to buy a dozen of eggs, in Russia 3 hours; 25 minutes for a pound of bacon, in Russia 5½ hours. In Russia, it takes 2 hours to buy a bar of soap or a package of cigarettes; 8 days to buy a pair of leather shoes; and 6 weeks to buy a suit of clothes.

The significance of our increased productive capacity in agriculture was strikingly demonstrated during and immediately after World War II. Had farmers in 1944 been compelled to go back to the machines and methods used 25 years previously, 4½ million more farm workers would have been required to produce the same amount of food.

Obviously, the war effort would have been seriously impaired if that many more people had been required to produce essential agricultural products. Furthermore many of our top statesmen have indicated that the food which we made available to a starving world following the War was one of the greatest of all deterrents to the spread of Russian communism throughout the world at that time.

These contributions of agricultural science have been tremendous. We should be proud of them. But we shouldn't rest on them—not when we think what comparable developments could do for the Communists. Russia still has about 45 per cent of its population working in agriculture—comparable to our position about 75 years ago. But, remember, if the Russians could equal our current capacity to produce food and other needed agricultural products, they would have some 60-70 million farm people free to do other things. What this would mean to a Communist dictator! What manpower to build an even greater war machine! What multitudes to put to work in missile industries! What possibilities of economc development to use in strengthening the Communists' position, not only in the Iron Curtain countries but with

the neutralist nations as well!

Obviously, we can do nothing about Russia's scientific progress. At present, we are well ahead in the development and application of agricultural science. Our only course of action is to *stay ahead, well ahead.*

Our first task is to make sure that we have sufficient numbers of well-trained agricultural specialists. The opportunities for college graduates in agriculture are undoubtedly greater today than ever before. Agricultural colleges all over the country report an acute need for 2 to 3 times the number of graduates that they are now turning out.

The seriousness of the present shortage of well-trained agricultural specialists is reflected in a recent statement by Texas A & M Vice Chancellor in Charge of Agriculture, D. W. Williams: "Agriculture faces a drying up of trained leadership at its source. There just simply are not nearly enough young men entering agriculture . . . There is," he said, "a danger to the whole country if this downward trend in interest isn't checked. We will just wake up some day and there will be nobody to hire or to run the farms or to explore agricultural research."

Careful attention must be given to means by which this serious shortage of trained agricultural specialists can be overcome.

Furthermore, we should make a careful review of educational requirements—both in college and in preparatory schools, giving consideration to increasing requirements in mathematics and basic sciences.

Consideration should also be given to some more systematic and complete program by which we can keep abreast of latest foreign developments in agricultural technology. There is an especially great need for a system whereby foreign scientific literature — particularly Russian—can be translated and made available to our agricultural scientists.

We cannot lose *this* technological race—one that could be far more important than launching Sputniks. We must go all out to maintain our present superiority in agricultural science. We have no reasonable alternative, so long as freedom and food are important to men. ◄◄◄

INCREASING LIFE SPAN OF ALFALFA

. . . AND OTHER LEGUMES

Legume stands will stay down longer and farmers can save the expense of frequent reseeding when pastures are topdressed regularly with phosphate and potash fertilizer.

The plant nutrients in the mixed fertilizer will increase the life span of the alfalfa and other legumes in your pasture, report Midwest agronomists.

This means you do not have to reseed the legumes so often and so you save money. Costs go up every time you plow or rework the soil to reseed the legumes in the pasture. The less often you have to do this, the more you will save in the long run.

Legumes have a big appetite for phosphate and potash. If the soil is low in these nutrients, the legumes will lose out and grass will take over in the pasture. So it pays to see that the soil is regularly supplied with these nutrients.

Here, closeup, we see part of a good field of row peppermint. Adequate potash fertilization has improved stands by giving plants (especially row mint) more vigor in spring, Michigan State experiments show.

Here mint hay is chopped into metal portable tubs or vats which are hauled to the distill for separating the oil from the hay by steam evaporation. It takes about 50 minutes to remove the oil from a load.

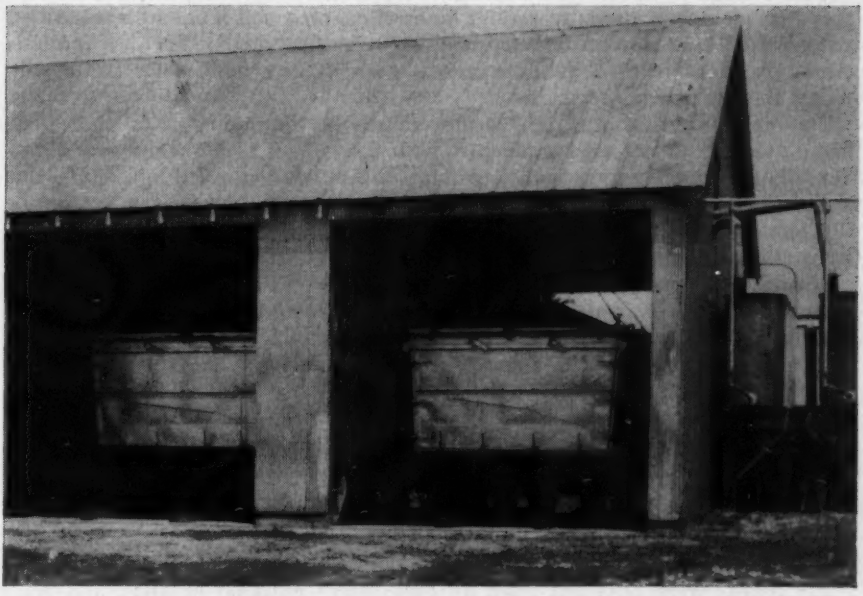
MINT:

THE PLANT THAT FLAVORS MUCH OF OUR CHEWING GUM, DENTIFRICES CANDY, AND PHARMACEUTICALS

MINT—the plant from which we get the flavoring for much of our chewing gum, dentifrices, candy, and pharmaceuticals—was first grown on organic soils in Michigan about 1890. Two kinds of mint—peppermint (Mentha piperita) and spearmint (Mentha spicata)—are produced in the state. The black peppermint (Mitcham) is the most extensively grown variety.

Dr. J. F. Davis, head of Soil Fertility Research at Michigan State University since 1955, is a native of that state, having earned his Ph.D. at Michigan State in 1943. Today he is recognized as one of the leading authorities in the nation on organic soils.

Both the common spearmint and a horticultural variety known as Scotch are grown. The common spearmint has longer, lighter green leaves and more slender flower spikes. The flowers of Scotch mint form in the whorls of the leaf axils—a variety preferred because of its greater productiveness. The quality of the oil produced in the Midwest is generally preferred by the



Here, we see metal portable tubs (from the rear) in position to remove mint oil from hay by distillation. The steam is spread by means of several perforated pipes on the bottom of the tub. Steam outlet is conductor pipe shown leading from top of wagon lid. Condenser tanks are shown at right of the building. The spent hay is dumped from front of tub.

Grown On Organic Soils

trade that demands the finest in oil quality.

Mint is a hybrid that rarely produces viable seeds. It is propagated by underground root stocks (stolons) and by surface runners. The root stocks are generally dug with a machine similar to a potato digger that lifts the roots from the soil. They are generally planted in April or late fall in furrows 3 to 5 inches deep, and in rows 32 inches apart. A manure spreader can be satisfactorily adapted for this planting operation.

Plants originating from the nodes of stolons are transplanted during May and the early part of June. The first crop (row mint) is harvested the year that the plants are set. After the first year, the crop is designated as meadow mint. Generally one crop per year is harvested, although occasionally a second crop is taken.

By J. F. Davis
R. E. Lucas and L. N. Shepherd

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Michigan State University

The average yield of oil in Michigan is approximately 22 pounds per acre. This low yield is caused by serious infestation of a soil-borne disease called wilt (Verticillium albo-atrum var. menthae). A fair yield is 30 to 40 pounds and an excellent yield, 70 to 90 pounds per acre. Spearmint yields are usually higher than peppermint yields.

The oil is produced in glands, located mostly on the underside of the leaves. The oil yield does not always increase with the weight of herbage. To stimulate oil gland activity, growth regulators have been applied on mint—but to little avail as yet.

Mint is hard to work with because of the wide seasonal variability that occurs in response to fertilizers and management practices. This variability is demonstrated by the following data: oil yields of 36.5, 9.5, 15.9, and 33.5 pounds per acre obtained from plots of the *same treatment* in a 4-year-rotation experiment for the years 1949, 1950, 1951, and 1952.

The experiment occupied a space of approximately 1½ acres on a *uniform site,* minimizing the effect of soil differences. These wide differences could not be consistently correlated with precipitation, height of water table, maximum and minimum temperatures, heat units or Langley's (a measure of solar radiation units).

Fertilizers

Mint responds to nitrogen, phosphorus, and potassium. Typical responses to phosphorus and potassium fertilizers on muck soil are shown in Table I. These results were obtained from an experiment initiated in 1941 and continued on these plots since that time.

Table I.—The effect of fertilizers on the yield of peppermint oil, Michigan State University Muck Experimental Farm, 1952-1956.

Pounds per acre (annually)			Pounds oil per acre*					
N	P_2O_5	K_2O	1952	1953	1954	1955**	1956**	Average
*0	200	100	26.3	49.1	33.7	57.7	37.0	40.7
0	100	100	32.7	49.1	35.0	42.1	37.0	39.2
0	100	200	36.2	40.2	30.0	55.3	31.7	38.7
0	100	300	25.6	34.5	23.6	39.9	26.3	29.9
0	0	300	11.7	27.2	22.9	15.3	23.9	20.2
0	200	0	30.9	36.3	32.2	25.5	32.8	31.5
0	0	0	15.4	22.7	19.8	35.0	15.8	21.7

* Averages of 5 replications in 1952–1954 and 4 replications in 1955–1956.

** 50 pounds of N per acre applied in 1955 and 1956 on plots receiving fertilizers.

Here we see the mint crop responding to approximately 100 pounds of potash and 100 pounds of phosphate annually. Here we see both phosphate and potash are necessary to obtain maximum yields. These results were obtained under conditions where wilt was not a factor. There is considerable variation in the yield of mint oil and the response to the various fertilizer treatments between years.

Adequate potash fertilization has improved stands by giving plants *more vigor* in the spring—especially row mint. Plots receiving the most potash usually produce the highest hay yields in the experiment. Unfertilized plots often yield less than 25% the hay of adequately fertilized plots. But *the yield*

of oil per pound of hay is, in many cases, substantially lower from the higher hay yields.

In Fig. 1, we see the amount of potash removed by a 10-ton crop of green mint hay. At harvest time, the extractable potassium in hay from plots receiving 100 pounds of potash annually was approximately 5,000 parts per million (ppm). This equals approximately 100 pounds of potash in the mint hay produced on an acre. Add about half of this quantity contained in the roots and stolons, and the full content of the plant totals approximately 150 pounds of potash per acre.

In Fig. 2, we see the content of water soluble phosphorus in green mint hay from plots receiving different amounts of phosphate annually. As the phosphate was increased, the amount of water soluble phosphorus increased. The respective amounts of water soluble phosphorus found in mint tissue where 0, 50, and 100 pounds of phosphate were applied annually were 90, 190, and 250 ppm.

These figures cannot be converted into pounds of phosphorus per acre in mint because not all of the phosphorus found in plant material is water soluble.

Table II.—The effect of nitrogen on the yield of peppermint oil, Michigan State University Muck Experimental Farm, 1952.

Pounds nitrogen* per acre		Pounds oil per acre	
Planting time	Top-dressed	Row mint	Meadow mint
25	—	49.7	23.8
100	—	52.2	17.6
200	—	51.3	19.9
25	75	45.6	20.2
25	175	50.4	17.5
No nitrogen	—	38.7	15.2

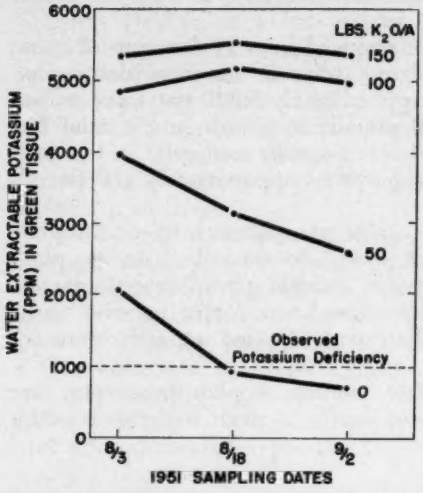
* 500 pounds of 0–20–20 per acre applied on all plots.

Nitrogen

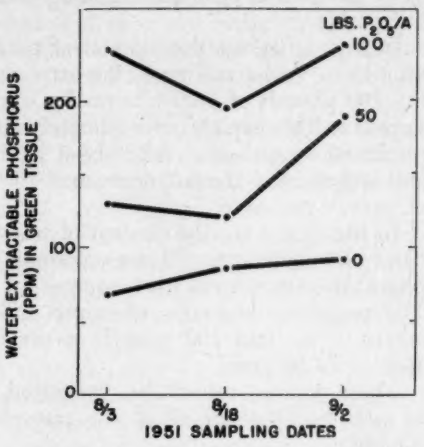
In Table II, we see the effect of nitrogen on yield of peppermint oil. In 1952, the yields of row mint were increased *11 pounds per acre* when 25 pounds of nitrogen were included in the fertilizer at planting time. Increasing the amount of nitrogen to 200 pounds per acre did not materially increase the yield. Meadow mint did not respond to nitrogen as fully as row mint.

Although this table shows yield differences very often occurring between row mint and meadow mint at Michigan State University Experimental Farm, several farmers report the reverse of this trend.

Response to nitrogen depends on the pH of the soil, the height of the water table, the amount of rain, and the temperature. In cold, wet periods, when the water table is high or drainage only fair, good response to nitrogen is expected. When the soils are well-drained and temperatures warm, bringing microbial activity in the soil to a high level, response to nitrogen is not as great. Generally, 25 to 50 pounds of nitrogen per acre are recommended for mint.



Seasonal changes in the concentration of water extractable potassium in peppermint stems as influenced by different amounts of potash applied annually to an organic soil for a 10-year period.



Seasonal changes in the concentration of water soluble phosphorus in peppermint stems as influenced by different amounts of phosphorus applied annually to an organic soil for a 10-year period.

Minor elements are relatively unimportant to the production of this crop. Occasionally, 10 to 20 pounds of manganese per acre on nearly neutral to alkaline soils will increase oil yields. Four pounds of copper are usually recommended for both peppermint and spearmint growing on peaty soils with a pH of 5.5 or below.

Moisture Requirements of Mint

Mint grows well on a relatively high water table. This water table can start out in the spring at 16 to 18 inches and progressively decline through the season until it reaches about 26 to 30 inches.

The water table depth depends on the nature of the soil—whether the water movement throughout the soil is rapid. It also depends on water control. If the water can be controlled within precise limits of 2 to 3 inches, a higher water table can be tolerated than if the water control system is not adequate to reduce the dangers of seasonal floods and extended rainy periods.

The question of supplemental irrigation often arises. Table III actually shows that 5 inches of water applied on irrigated plots during 1952, on the average, decreased the yield of oil. If extremely dry conditions persist, mint will respond to irrigation.

Supplemental irrigation does have advantages. It will help prevent frost damage, because a moist surface is less frosty. Also, wind damage can be minimized and often prevented if irrigation equipment is available. Where irrigation is possible, the surface of the soil can be kept moist in the spring when planting operations are either under way or completed. Irrigation may also help control wilt. We do not mean to imply this will take care of the wilt problem effectively. But it may help.

Transplanting Versus Planting of Roots

A clean source of roots is essential to establishing mint fields. This means freedom from verticillium wilt. Producing the plants on wilt-free areas is recommended. Approximately one acre of *good roots* will plant 10 to 20 acres

Table III.—The effect of irrigation and fertility levels on the yield of peppermint oil, Michigan State University Muck Experimental Farm, 1952.

Pounds per acre N — P_2O_5 — K_2O	Pounds oil per acre† Irrigation*	No irrigation	Mean
0–10–50	21.9	32.7	27.1
0–200–100	30.5	26.3	28.4
0–50–50	15.1	22.7	18.9
0–100–100	34.4	32.7	33.6
0–50–100	20.9	28.1	24.5
0–100–200	34.2	36.2	35.2
0–50–150	18.2	20.3	19.3
0–100–300	20.6	25.6	23.1
Mean	24.5	28.0	

* 5″ water applied on irrigated plots. Roots planted April 25 and harvested August 18.

† Means yield from plots receiving 500 and 100 pounds of fertilizer were 22.4 and 30.1 pounds of oil per acre respectively.

of row mint. Table IV shows oil yields from root plantings are considerably higher than yields from transplants. Generally, roots should not be planted deeper than 4 to 5 inches. Wilt injury is less in root plantings than in transplanted plants.

How Long Should Mint Be Produced Consecutively on the Same Field?

Only one crop of mint every four years should be grown on an organic soil. Unfortunately, farmers do not usually follow this practice. And they soon learn, at their own expense, that wilt increases under continuous mint production.

Rotations at the Michigan Muck Experimental Farm definitely show that mint cannot be grown profitably for more than five years in a rotation where mint is produced *two out of four years.* This area was wilt free at the time the experiment was established. Wilt can become so severe that mint production is unprofitable.

Tillage and Cultivation

Minimum tillage is recommended for mint production. This means plow-

Table IV.—Effect of planting methods on yield of peppermint oil, Michigan State University Muck Experimental Farm, 1949 and 1950.

Treatment	Pounds oil per acre 1949	1950
Transplanted*	37.3	—
Roots 4½″ deep†	49.8	28.9
Roots 8″ deep	54.2	23.0

* Harvested September 9.

† Harvested August 22.

Fertilizer—500 pounds 0–20–20 per acre.

Planting dates—April 28 and June 10, 1949; April 19, 1950.

ing, harrowing lightly once, then immediately planting.

The fertilizer can be broadcast and disked in before planting or sidedressed after the roots are planted. Leave the surface of the soil rough, to minimize wind erosion damage. Cultivate as late as possible, to prevent frost damage.

As soon as the soil surface is cultivated, a mulch forms on the surface as a good insulator. During frosty nights, heat release is slowed and frost injury can easily occur. To control weeds, use a suitable herbicide—such as dinitro weed killers, currently recommended at the rate of 3 to 4½ pounds per acre. Apply it at the time mint starts to emerge. It protects the crop 3 to 5 weeks.

A rubber tooth drag or finger weeder is an excellent way to control small weeds. The teeth of the rubber drag are made from discarded truck casings, split in the center with 3- to 4-inch sections of the split casing mounted on a wooden frame forming the teeth. The beaded part of the casing works the soil.

Recently, some fields infected with wilt, especially in Indiana, were plowed 26 to 30 inches deep with a mold board plow to help control wilt. *Results show temporary control.*

However, the unplowed borders of the field always threaten reinfestation. Deep plowing is not wise, if the organic soil is not deep, because sand and marl brought to the surface can reduce crop productivity.

Harvesting

Mint is usually harvested by a sickle-bar mower. Row mint is often cut by a mower equipped with vine lifters used for pea harvesting. Rotating saw disks will also cut it. Rotating saw disks clog less easily and cut more readily through hay that has lodged.

After the mint is cut, the hay is partly dried in the swath, then raked into windrows with a side delivery rake. This operation must be done while the leaves and stems are *tough from evening dew.* The nearly cured hay can be hauled loose to a distill or coarsely chopped by a forage harvester. See Fig. 3.

Steam distillation removes mint oil from the hay—in stationary round tubs located at the distill or on metal covered vats mounted on a wagon (Fig. 4). It takes about 50 minutes to remove the oil from each load, using 40 horsepower boiler capacity per tub.

Steam evaporation separates the oil from the hay. The mixture of steam and oil vapors are condensed in a warm or tubular condenser surrounded by cold water. The condensate of oil and water then flows into a receiver can. Since mint oil floats in water, the receiver draws water off the bottom through a pipe extending up the side within a few inches of the receiver top.

For rapid separation of oil from water, Oregon studies show, the condensate mixture should be held at 110° to 120° F. Such a temperature can be maintained by a sensing element located in the condensate drain pipe, regulating the flow of cooling water going into the condenser tank.

Time of Harvest

Table V shows the effect of harvest on the yield of oil. In 1949, the yield of oil *doubled* in a 12-day period. Here and in Tables VI and VII we see what influence crop maturity and the drying period have on oil yield. They indicate *an optimum time* for harvesting, since the oil yield tends to increase with maturity to an optimum and then decreases.

Table VI shows high recovery from hay cured two days, but over twice the distillation time required for hay cured three or four days. It was impossible

Table V.—Effect of spacing of plants in the row and date of harvest on the yield of peppermint oil, Michigan State University Muck Experimental Farm, 1949 and 1950**.

1949					1950		
Harvested Sept. 8			Harvested Sept. 20		Harvested August 30		
Spacing (in.)	Pounds oil	Tons green hay	Pounds oil	Tons green hay	Pounds oil	Tons green hay	Pounds green hay per pound oil
6.2	21.0	4.9	32.6	8.3	20.4	7.8	793
12.4	15.8	4.3	31.6	8.3	19.6	6.7	700

* Fertilizer—500 pounds 0–20–20 per acre. Transplanted dates—June 15, 1949 and June 3, 1950. Yields expressed as tons of hay or pounds of oil per acre.

to recover as much oil from green hay, regardless of distillation time, as from hay cured for two days. Extremely dry and brittle hay does not yield well either, grower experiences show.

The percentage of total methol generally increases as the plant approaches maturity; however, it does not consistently correlate with the yield of oil—as borne out in Table VII.

Hay

The spent hay left after distillation, often called *pumy*, is usually spread back on the land as organic residue. High in plant nutrients, pumy contains all the plant residue. Growers who chop the hay before distillation can easily spread the residue with a manure spreader.

Unchopped hay is difficult to handle cheaply. It is often left in a pile to decay before an attempt is made to use it. If spread on the field by hand, it should be rolled down and disked. Later, it can be plowed down with a large, single-bottom plow.

The spent hay has also been used by livestock farmers for feed because of its high protein content.

Quality of Oil

Many factors influence the quality of mint oil.

Some common causes of poor quality are: (1) weed contamination in mint hay; (2) rusty containers, conductor pipes, condensers and receiving cans; (3) storing in a warm place and letting oxygen react with the oil; (4) foreign

Table VI.—The effect of time of curing on the composition and recovery of peppermint oil, Michigan State University Muck Experimental Farm, 1955.

	Time of distillation (minutes)	Oil† grams	Esters, percent	Menthol total, percent
Green hay	160	321	4.67	47.82
Cured 2 days	120	405	4.47	45.62
Cured 3 days	50	—	5.88	50.88
Cured 4 days	50	396	5.97	48.88

Table VII.—The effect of time of harvest on the composition and yield of peppermint oil, Michigan State University Muck Experimental Farm, 1955.

Meadow mint					Row mint				
Date cut	Tons green hay per acre	Pounds oil per acre	Per-cent esters	Percent total menthol	Date cut	Tons green hay per acre	Pounds oil per acre	Per-cent esters	Percent total menthol
July 19	8.6	29.9	5.14	48.30	Aug. 22	4.3	18.7	6.97	51.78
July 22	11.9	37.1	5.49	48.98	Aug. 24	4.9	23.7	4.53	43.56
July 25	13.9	26.5	6.99	56.29	Aug. 26	4.7	20.5	6.02	48.84
July 27	11.0	22.0	7.07	47.74	Aug. 31	5.8	18.2	8.09	54.23
Aug. 1	8.3	37.0	—	—	Sept. 2	7.3	28.3	6.84	53.94
L.S.D. (5% level)	2.1	7.4	—	—	Sept. 7	6.9	27.6	8.01	55.96
					Sept. 9	6.4	27.8	7.37	56.34
					Sept. 12	6.3	24.7	9.44	64.36
					Sept. 16	5.4	24.8	9.87	62.62

* Data for row mint obtained from a composite sample from two replications. Yield data from meadow mint expressed as averages of three replications. There was no precipitation on hay.

materials on the herbage, in the distillation water, and in the containers; (5) growing plants in areas and/or in periods of short daylight or excessively long daylight.

Using hot, dry steam can also impair quality, as well as using oil obtained from surface stolons, old leaves, or from recovery oil dissolved in the condensate water leaving the receiver can.

Major insects attacking mint are mint flea bettles, cut worms, loopers. wire worms, and grasshoppers. They can be controlled by proper insecticides used according to recommendations.

But using an insecticide improperly easily contaminates mint oil. Other major diseases of mint besides wilt are anthracnose (Sphaceloma Menthae) and Rust (Puccinia Menthae).

[1] Contribution from the Soil Science Department, Michigan Agricultural Experiment Station. Authorized for publication by the Director of the Station as Journal Article No. 2047. ◀◀◀

"INTELLIGENT USE"

"I regard conservation as use—intelligent use—of our resources to provide for the needs of people in a growing economy, while at the same time preserving and enhancing the capacity of these resources to continue to produce the materials for the use of people now and in the future. Natural resources can have no significance except as they are related to the needs of people. Fertile fields, great forests, the latent powers of our great rivers are of concern to us only as we can use them to satisfy our physical needs. Resources unused are sterile. Resources require management to prevent their exhaustion and needless dissipation. They are to be used wisely so that they may be renewed after each use. Conservation means use without abuse—use of the product without eating up the capital."

Assistant Secretary of Agriculture E. L. Peterson

WITH SAFE GUIDANCE

Soil testing laboratories in 100 Missouri counties now enable any farmer in the state to inventory the plant foods and organic matter in his fields and pastures.

Developed in the last 10 years by the College of Agriculture and local groups, these laboratories are successful in large measure because they can interpret tests of a farmer's soil samples in terms of the Station's results of research with fertilizers on soils with the same plant food deficiencies as those indicated in the farmer's tests.

With this safe guidance farmers buy their fertilizers wisely. By doing so they save money for themselves and help in the general improvement of fertilizers sold in Missouri. During the last ten years, 1947-1956, the average percentage of available plant foods in commercial fertilizers used in the state increased from 20 to 33 per cent.

All county units have been financed locally, and local persons are trained to operate them under supervision by the Extension Service. Chemicals and equipment are purchased and standardized by the Experiment Station to be sent to the counties as needed. Station research men also have devised instruments, charts and tables for reading the tests and translating them into specific kinds and amounts of fertilizer indicated for each soil and crop.

During the last three years more than 100,000 soil samples were tested per year, and in 10 years farmers made 3½ million visits to their local labs with soil samples to be tested. They have learned that test-guided use of fertilizer gets maximum results from soil treatment outlays of time and money.

University of Missouri, College of Agriculture

MAKING UP FOR LOST TIME

When wet weather delays your corn planting in spring, you can help make up for lost time by using starter fertilizer in the row at planting time.

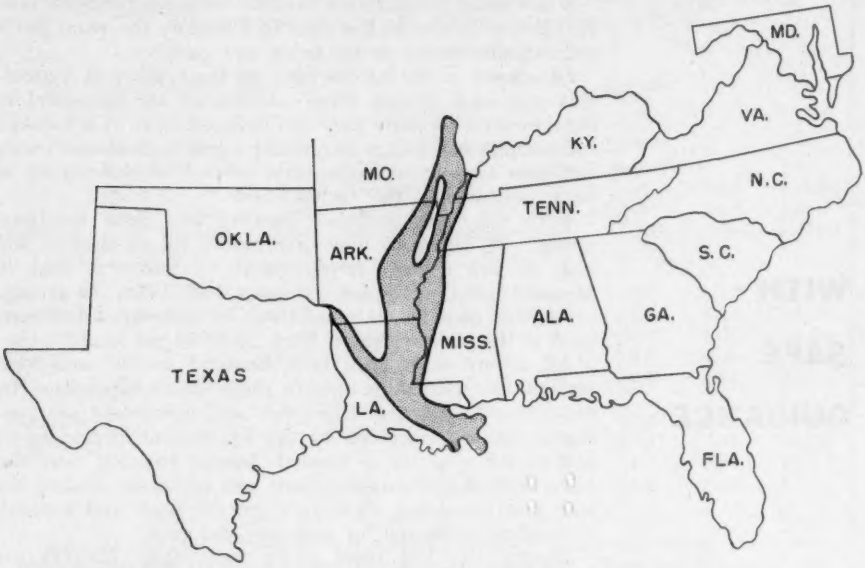
This starter fertilizer will speed growth of young plants, states M. D. Weldon, Extension agronomist at the *University of Nebraska* College of Agriculture.

In many wet areas of the Corn Belt last spring the soil remained cool for some time. This tends to delay germination and early growth of corn and other crops.

By putting plant food near the roots of young seedlings, properly placed starter fertilizer will give them the nitrogen, phosphate and potash needed for a quick start and sturdy early growth—Weldon explains. This helps make a thick stand that gives high yields and low costs per acre.

Starter fertilizer with the corn at planting time can increase yields as much as 10 or more bushels per acre when the weather after planting is cold, wet and unfavorable.

You will get better placement of fertilizer with the split boot attachment on your corn planter, if you keep tractor speeds low at corn planting time, Weldon adds. The adjustable single boot attachment still is better. This will give more even spacing of the corn and a better stand.



In shadow is the general location of the Southern Alluvial Plain.

ALLUVIAL soils have played a major role in the food production and the economic conditions of nations throughout the earth. It is well, now, to pause and pay tribute to our flood-plain areas.

Such consideration seems especially appropriate at this time in view of the trends in modern agriculture. Although we have experienced various government control programs, we live in an era of surpluses.

How long can American farmers continue to produce surpluses of major crops on reduced acres? No one can tell what the future will bring. All predictions and guesses are made on certain assumptions. Will agricultural trends continue in the same direction? Or will they change?

Every sincere, thinking person wonders what southern agriculture will be like just ten years from now. Whatever it is like, chances are our vast areas of alluvial soils will play a major role because of their adaptability to mechanized production of many food and fiber crops.

Although river valleys have their problems they have played important roles in the development and welfare of many civilizations.

Look at the Nile Valley. What would Egypt be like without the Nile River? "Egypt," it is said, "is the gift of the Nile." It might be better said the Nile River is a blessed gift to Egypt. For without the Nile, Egypt would be just another desert land.

Other classic examples are the Jordan, Euphrates, Po, Rhine and our own Mississippi Valley. How much have and do these valleys contribute

By H. B. Vanderford

Department of Agronomy

Mississippi State College

SOUTHERN ALLUVIAL PLAIN

. . . **WHERE** the importance of pastures and livestock is growing in the Red and Arkansas River Bottom, and in other areas of the floodplain region.

FOOD AND FIBER BASKET OF THE SOUTH

to the welfare of the world?

The Southern Alluvial Plain is one of the youngest land forms found in the Southland. As the name indicates, this region is a floodplain or the product of large stream activity and deposition. Thus, the land is about level with a few slopes serving as natural levees. These levees occur as ridges, usually running parallel to the stream courses.

Location and Size of Region

This alluvial valley extends from southeastern Missouri down the Mississippi River to the Gulf of Mexico. Additional wings run up the Arkansas and Red Rivers into Arkansas and Louisianna. This forms a belt of rich land about 600 miles long and over 100 miles wide at some points.

The Southern Alluvial Plain provides important agricultural areas for Missouri, Kentucky, Tennessee, Arkansas, Louisiana, and Mississippi. The acres of floodplain soils vary among these six states, but are great enough in each state to influence the agricultural welfare of the area.

The great importance of Southern Alluvial Plain soils can be appreciated when compared with the other regions of the South. More and more of our upland soils are being retired from cultivation. The trend is toward fuller use of our alluvial soils.

Basic studies and investigations of the principal soils found in the floodplain region, are becoming more important. These soils are naturally

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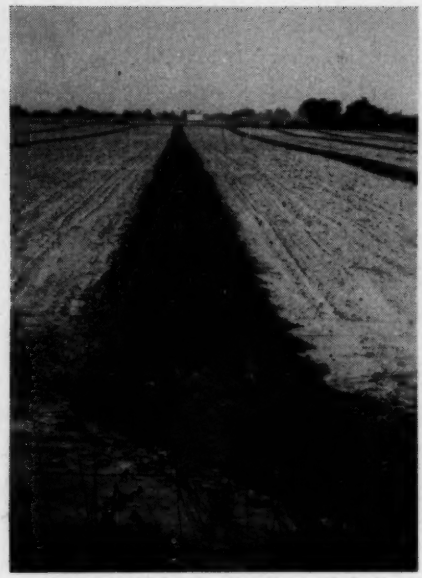


. . . **WHERE** mechanized farming is a general rule, on the floodplain that contains large areas of nearly level land suitable for operating heavy machinery.

. . . **WHERE** cotton is "king" of crops and "queen" of the fibers and can be produced with little farm labor.

young, and scientific investigations regarding their nature and characteristics have been limited, so far.

Because of difficulties and hazards, the Southern Alluvial Plain was the last region in the South to be settled and developed. Frequent floods, swampland, disease, and insect pests were all encountered and had to be conquered. These hazards delayed the eager, ambitious upland people attracted by the production possibilities of the rich alluvial land.

Origin and Nature of Soil Material

As the name implies, the Southern Alluvial Plain is a product of stream action. By their nature, streams cut out valleys and then deposit alluvium over the valley floor. This valley flat, covered with alluvium varying in thickness, is known as a *floodplain*. These land forms vary with the nature and age of the streams causing them.

Soil Development

Soils are products of five independent factors. These factors are *parent material, climate, vegetation, topography,* and *time*. All five factors play a part in the genesis or development of every soil type. The nature and characteristics of the soil at any point on the surface of the earth represents the influence of the combination of these five factors of soil formation at that point. Since five factors are involved, the relative importance of each varies from place to place.

Parent Materials

Alluvial sediments varying greatly in physical and chemical composition were deposited by the Mississippi River and tributary streams. These sediments form a blanket of alluvium

. . . **WHERE** planting and harvesting sugar cane in the Mississippi Delta area of Louisiana is a major operation—on a major cash crop.

. . . **WHERE** rotation of rice and fish is gaining popularity, with rice fields producing huge quantities of 3-5 pound Buffalo fish each year.

over the floodplain usually over 100 feet thick. Since most of the soil materials were transported from the northern and western states where the climate is cooler and drier, the fertility level of the alluvium is relatively high.

Climate

The climate of the Southern Alluvial Plain is warm and humid, characteristic of the South in general. Climate here is a relatively uniform factor in soil development and has not yet made much impression on the soils. Soils that have been free from flood long enough for soil development to be evident more nearly resemble those found in cooler climates.

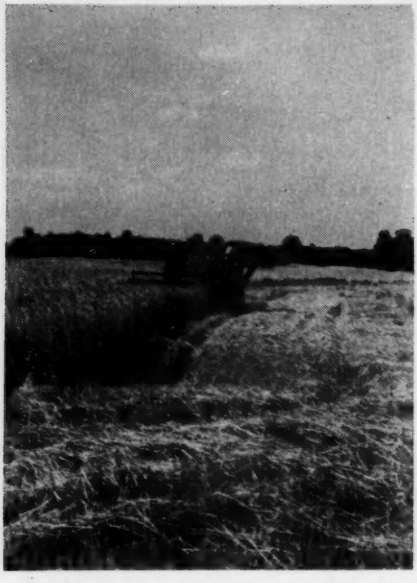
Topography and Drainage

The Southern Alluvial Plain is almost level, characteristic of most floodplains. The lay of the land ranges from the flat areas of "buckshot" or slack-water clays to very gently sloping natural levees. Most of the slopes have gradients of less than 3 percent. Generally speaking, the floodplain appears as an immense area of flat land.

The level topography has caused slow, poor drainage conditions that have influenced the soils greatly. Water moves off and through the soils so slowly that drainage is a problem. Many of these soils have developed under wet, swampy conditions—a factor greatly influencing the soils of the floodplain.

Native Vegetation

The early settlers of the Southern Alluvial Plain found a dense cover of bottomland hardwoods with canebrakes scattered about in the more open areas. Heavy stands of cypress and old bayous covered the swampy areas, with hardwoods covering most other lands. The differences seem due



. . . **WHERE** rich alluvial land will produce great quantities of high quality grains, such as this field of wheat in Arkansas.

. . . **WHERE** soybeans are an important crop, playing a significant part in the land use pattern throughout the Southern Alluvial Plain.

to drainage and elevation of the sites.

The ridges or natural levees were covered with hickory, pecan, white oak, nuttal oak, blackgum, and elm. Tupelo gum, cottonwood, overcup oak, sweetgum and willow oak covered the flat areas where drainage was poor. Cypress and willow covered the wettest areas. Canes and vines covered the open areas that received the most sunlight.

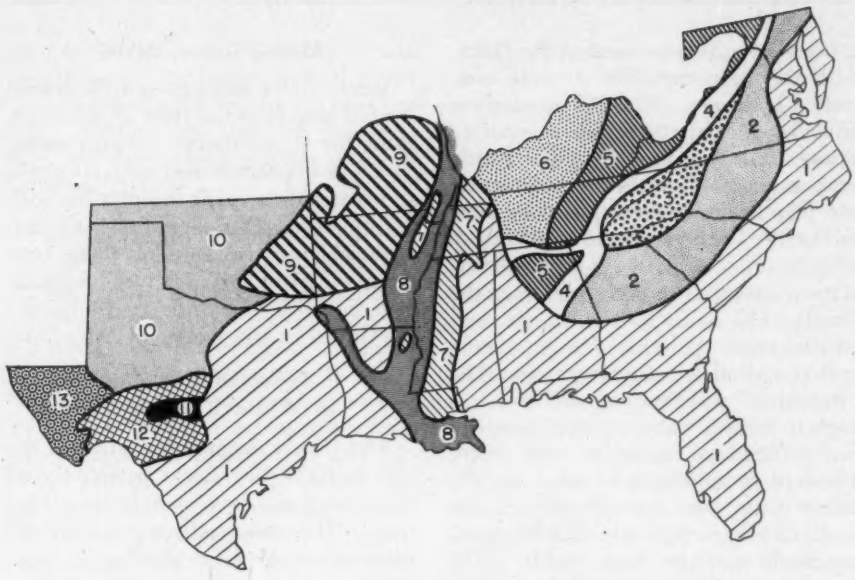
Soil differences caused by the original vegetation can be observed among the soils, but these are minor. Influence of such vegetation was probably quite noticeable when the lands were first cleared and settled.

Time

As mentioned before, the floodplain is a young landform. Though some of the soil materials have been deposited several thousand years, the soils have not developed distinct profiles. The old natural levee formations have been free from frequent floods and overflow water longer than the other land surfaces. Here the drainage is also better than in other areas. These ridges, which were cleared first, have lost the most plant nutrient by leaching, erosion, and crop removal. Therefore, soil development has advanced more in the soils of the old natural levees than it has in the soils of the slackwater, swampy areas. Some profiles have distinct horizons, but none can be classified as mature soils.

Divisions and Agriculture

The vast region of the River Floodplain can be divided into sub-regions —by soil materials—associating major areas with definite streams. For example, the Southern Alluvial Plain can be divided into the following subregions: Mississippi Delta, White River Basin, Arkansas River Bottom,



Physiographic regions of the South: (1) Coastal Plain (2) Piedmont (3) Blue Ridge Mountains (4) Great Valley (5) Appalachian Mountains (6) Central Basin and Interior Plateau (7) Loess Region (8) River Flood Plain (9) Ozark Region (10) Great Plains (11) Central Basin of Texas (12) Edwards Plateau (13) Mountains and Basins Region of Texas

and Red River Bottom. Since the Arkansas and Red Rivers deposit similar sediments, these two areas can be combined. This leaves three main sub-regions, each important and distinct.

Mississippi Delta

This area extends from southeastern Missouri down the Mississippi River to the Gulf of Mexico. The area is made up of belts of land on both sides and parallel to the Mississippi River. Narrow strips of delta land occur in Missouri, Kentucky, and Tennessee and larger belts occur in Arkansas, Mississippi, and Louisiana.

The soil materials or sediments in the Mississippi Delta were deposited largely by the Mississippi River. In some places, the recent Mississippi River sediments developed over older sediments deposited by the Ohio and Arkansas Rivers.

The sediments vary from sands to clays, transported from a variety of sources generally in the northern and western states. The sediments are all relatively high in native fertility. This is reflected in the fertilization practices used by the planters of the Delta area.

The soil mapping was established by studying the important soil characteristics as observed in the field. The first important soil characteristic was found to be the *physiographic position;* the second important characteristic, *internal drainage;* third important soil characteristic, the *texture* of the surface layer.

Type of Farming in the Mississippi Delta

The nature of Mississippi Delta soils and their location on a level topography make it possible to practice highly specialized farming. Drainage

systems operate over most of the Delta, with the Mississippi River now controlled by levees. Thus, Delta planters have large fields in which to operate heavy farm equipment, with little erosion problem. And the planters do not fear frequent floods, as they once did before the levees were constructed.

As mentioned earlier, Delta soil fertility surpasses any other region in the South. The sandy soils are easy to cultivate, most desirable for producing cotton and other cultivated crops. The "Buckshot" and fine textured soils are high in fertility except in nitrogen, but are difficult to work in row crops. Planters producing row crops on the heavy land use special preparations and other practices to establish good seedbeds and get high yields. The large fields all over the Delta section naturally fit plantation-style farming.

Cotton is king of the crops from southeastern Missouri to Louisiana. In Louisiana, cotton gives over to sugar cane production. Since acreage control on cotton, only 30 to 40 percent of the land is now planted in this crop. The rest of the land is used to produce small grains, soybeans, pastures, rice, and corn.

Very little Delta cotton land was put into the recently established "soil bank," while much upland cotton area went into the "bank." How long will it be before Delta planters can farm more acres of cotton? It seems, at the moment, that much of the upland area will be retired to pine trees. And if the upland soils are taken out of cultivation, what effect will this have on Delta agriculture?

It seems logical that a concentration of row crops could be produced in the rich Delta, with the thinner upland soils used to produce pine timber. This leads our attention again to the natural advantages of producing cotton, as well as grain and other crops in the Delta area.

White River Basin

White River Basin is an area of land located largely in the state of Arkansas, along the White River. In many cases, its silt is deposited over alluvial clays, and water movement through the soils is very slow. Drainage, thus, is a major problem. Because of these conditions, part of this area was originally covered with wet-land grasses, called the Grand Prairie section of Arkansas.

Types of Farming in White River Basin

The poorly drained condition of the soils in the White River Basin delayed its agricultural development for a long time. The early settlers naturally developed the better-drained soils, leaving the wet ones in forests, marshes, and swamps.

Sometime along the way, however, they decided the flat, poorly drained silty soils should be used, if possible. So, rice was brought into the area. The soils were well suited for rice. And rice, today, has become the main cash crop of that area.

Other crops such as soybeans, small grains, and cotton are produced. Recently an interesting rotation has been established in the rice section of Arkansas. In such a rotation, rice is produced for two years, then fish for two years. Two kinds of fish are produced —buffalo for sale as fish, and minnows for bait. Considerable interest has developed over the last few years in this rotation. Many of the farmers, it seems, make more income from the fish than from rice. This rotation also qualifies "soil bank" payments while it is in fish production—a distinct advantage in terms of farm income.

Arkansas and Red River Bottoms

The Arkansas and Red River Bottoms areas extend up from the Mis-

sissippi Delta along the Arkansas and Red Rivers. Sediments in both floodplains were transported from the Permian Redbed formations of the western states—causing similar soils in both sections.

Types of Farming in Arkansas and Red River Bottoms

Throughout these areas, the farmers practice a general type of farming. Cotton has been the main cash crop for many years. Presently, however, much cotton land has been converted to rice. In addition to cotton and rice, small grains, soybeans, corn and pastures are produced. *Livestock has gained considerable importance during the past decade, increasing pasture land.* Fertilizers used in these areas vary from that used in the Mississippi Delta. In these sections, complete fertilizers are used for high cash crop yields.

Importance to the South

The Southern Alluvial Plain is one of the most important agricultural sections in the South. Nature was quite kind to the South where the Mississippi River decided to flow southward instead of eastward or westward. The South could have had a chain of mountains in place of a vast region of alluvial soil. What that would have meant to the agricultural and economic conditions of the Southland is obvious.

In the total area of the Southern Alluvial Plain, the South has over 20,000,000 acres. Because of its favorable topography, its fertility level, the response of its soils to good management practices, production possibilities here are greater than anywhere else in the South.

Cotton, king of the fiber crops, will be produced in the Mississippi Delta as long as it is produced anywhere. Other crops, such as small grains, and truck crops, can be produced abundantly. Mechanization can be used in the Alluvial flood plain better than anywhere else in the country.

It seems logical, therefore, that as the land is withdrawn from cultivated crops in the Hill sections, more room will be found for them in the Mississippi Basin. There is probably enough fertile land in the Southern Alluvial Plain, if handled with machinery, to provide all the food, feed, and fiber needed for a great portion of our southern population.

In addition to favorable topography, there is enough water in the natural lakes, large streams, and ground to irrigate most of the cultivated alluvial land. We do not know how much some of the better soils of the floodplain region would really produce under all of the improved soil management practices, including irrigation. This ready source of water gives the Southern Alluvial Plain another natural advantage over other sections.

Great quantities of fertilizers are used in the floodplain region, the kinds varying with the areas. The Mississippi Delta area is a big consumer of nitrogen, with some phosphorus and potash used in fringe and special areas.

The need for more *complete fertilizers* will no doubt *increase* as more subsoiling, irrigation, land leveling, and other practices are used for increasing yields on every acre of land. Fertilizer recommendations are now based on soil tests in the alluvial sections of all the states.

Many of the *grey silty* and *sandy soils* are low in fertility, with *nitrogen, phosphorus,* and *potash* needed for producing high yields of the major crops.

When all of these factors are considered, it is easy to see why the Southern Alluvial Plain is rapidly becoming the food, grain, and fiber basket of the South.

Abstracts

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Fertilizer Treatments Affect Ladino Yields and Stand

Wakefield, R. C., Shallock, D. A., Salomon, M., et al.

Yield and chemical composition of ladino clover as affected by fertilizer treatments. Agronomy Jour. 49(7):374-377. July 1957.

Response of ladino clover to increments of P and K up to 240 lb. per acre was investigated on a soil of initially low pH and fertility. Dry matter yields of ladino clover decreased steadily over the 4-year harvest period but satisfactory stands were maintained with 60 lb. P_2O_5 and 120 lb. K_2O per acre per year. Potassium content of plant tissue increased significantly as increments of K_2O were applied. Removal of K by the crop exceeded applications at low levels, approximately equalled the 120 lb. per acre application and resulted in excessive uptake at 240 lb. per acre. The Mg and Na content of the crop was significantly depressed at 240 lb. K_2O per acre. Exchangeable and nonexchangeable K in the soil accumulated at the 240 lb. rate. A decrease in nonexchangeable K occurred at the 0-, 30-, and 60-lb. rates.

Fertilizers Affect Maintenance of Clover Stands

Kalinkevich, A. F.

The causes of clover dying-off. Pitan. Rast., 90-103. 1955. R. Zh. (Biol.) 1956 (76354). Abs. Soils & Ferts. 20(1):326. Feb. 1957.

In pot experiments, mass dying-off of clover occurred not only during winter, but also during spring growth and in summer after cutting and seed-harvesting. It was markedly decreased by manuring. The percentages of growing plants at the end of the third year were: no manure 9%, with PK 38% and NPK 66%. The harmful effect of Autumn cutting was eliminated by PK.

Off-Season Fertilizing Pays on Legumes and Grasses

Munsell, R. I.

Opportunities for "off-season" fertilization in the Northeast. Plant Food Review 3(2):9. Summer 1957.

It now is common practice in the Northeast to apply split applications of K to legumes and two or more N treatments to grass crops. In the case of legumes or legume-grass mixtures it has been found that split applications decrease absorption of unnecessarily large amounts of K by the plants and helps to insure an adequate K supply for successive crops during the same season. An 0:1:2 ratio commonly is used in the Northeast, to maintain the P level and supply enough K. For example, if 400 to 600 lbs. of 0-15-30 is the total per year, half of it may be added following the first harvest, and the balance in the fall. On soils with a high available P level, straight KCl at 200-300 lbs. per acre in split applications may be substituted for the 0:1:2 ratio in alternate years.

Soybean Responses Still Mystery

Top soybean yields don't come easy. What's New in Crops and Soils 9(7):16-18. April-May 1957.

Why soybeans do not respond to fertilizers as corn, small grains, legumes or grasses is still a mystery to agronomists. Soybeans require large amounts of lime, N, P, and K but there must be some complex plant-soil relationship which is not yet understood. North Carolina research, reported by E. J. Kamprath, found that effects of stand, soil acidity, Ca, P, and K and organic matter accounted for only 28% of the variation in yields. The other 72% was apparently due to other factors, as yet unknown. Ohio agronomists recommend direct application of N, P, and K fertilizer in about the same amount which soybeans will take out of the soil.

Legume Seeds Boosted by Bees, Insecticide and Fertilizer
Holdaway, F. G., Peterson, A. G., Tubker, K. W., et al.
Better practices boost legume seed output in Minnesota trials. Croplife 4(29):16. July 22, 1957.

Researchers have discovered that poor pollination, lack of P and K nutrients in the soil and harmful insects have been responsible for low seed yields in alsike clover, red clover, alfalfa and sweetclover—Minnesota's main forage legume seed crops. With alsike clover, for example, where there were no honey bees for pollination, no insect control and no fertilizer were used, yields averaged 15-20 lb. per acre. But with honey bees nearby, 1000 lb. of a P-K fertilizer added and 1.5-2 lb. DDT sprayed on each acre, alsike yields went up to 800 lb. per acre. Results were similar in other seed crops.

How Freezing and Thawing, Wetting and Drying, Affected Potash Release and Fixation
Micka, J. J. and Lynd, J. Q.
Fixation and release of potassium in several eastern Oklahoma soils. Okla. Agr. Exp. Sta. Tech. Bul. 69, 16 p. June 1957.

Alternative freezing and thawing or alternate wetting and drying gave similar results on the release and/or fixation of K in all soils and treatments. All soils released a portion of their fixed K to the exchangeable form, then fixed a portion of that released by the end of the 4th cycle. A dynamic equilibrium between the fixed and exchangeable fractions of K functioned in all soils studied. Alternate wetting and drying resulted in a greater initial release of non-exchangeable K to the exchangeable form in all soils and chemical treatments, except for the untreated Bowie soil. Calcium increased K fixation in soils in a form not extractable with neutral normal ammonium acetate. The pH of all soils fluctuated during physical treatments, generally increasing with K release and decreasing with K fixation.

Clay Minerals—And Potash Fixation-Release
Mortland M. M., Lawton K., and Uehara, G.
Fixation and release of potassium by some clay minerals. Soil Sci. Soc. Amer. Proc. 21(4):381-384. July-Aug. 1957.

Release of K from fixed forms in an illite, montmorillionite, and vermiculite and from the native forms of an illite, biotite, and muscovite was investigated. Methods used in studying K release were chemical, electrochemical and biological. Changes in minerals following K release were followed by X-ray diffraction and chemical techniques. Results of the study indicated the K "fixed" by vermiculite and montmorillionite to be available for plant growth. The native K of biotite was a great deal more available for plant growth than that of an illite or muscovite.

Liming Influences Potash Retention
Gammon, N., Jr.
Effect of lime on retention of potassium. Fla. Agr. Exp. Stas. Ann. Rept. 1956. p. 131, 1956.

Soil maintained at pH 6.2 contained 20% more K than the same soil maintained at pH 5.4 after 2 years of shade tobacco production. This illustrates the value of liming in retention of fertilizer K. However, laboratory tests indicate that K leaching may be increased by excessive liming (above pH 6.5).

Effect of Drying Soil on Potash Availability
Scott, T. W. and Smith, F. W.
Effect of drying upon availability of potassium in Parsons silt loam surface soil and subsoil. Agronomy Jour. 49(7):377-381. July 1957.

Drying of both surface and subsoil approximately doubled exchangeable K content. Extensive cropping of soils not fertilized with KCl apparently reduced exchangeable K to near minimum levels. However, plant uptake of K always was greater from previously dried soil than from that kept continuously moist. A single unit of exchangeable K in continuously moistened soil was from 20 to 26% more available than the same unit in dried soil. Similarly a single unit in surface soil appeared to be from 10 to 16% more available than a single unit in subsoil.

Vascular Bacteriosis in Cabbage Affected by Nutrition
Ryzhkova, A. S.
Root nutrition and the resistance of cabbage transplants to vascular bacteriosis. Fixiol. Rast. 3, 399-404. 1956. Abs. Soils & Ferts. (20(1):301. Feb. 1957.

When 34-day-old cabbage transplants in water cultures were inoculated with Xanthomonas, resistance was greatest with $(NH_4)_2SO_4$ as the source of N, less with $Ca(NO_3)_2$ and least with NH_4NO_3. Resistance was increased by simultaneous high rates of P and K but was decreased by high N alone.

Effect of NPK on Photosynthesis and Respiration
Dorokhov, L. M.
The effects of nitrogen, phosphorus and potassium on the intensity of respiration in agricultural plants. Trudy kishinev. s.-kh. Inst. 8, 219-236. 1956. Abs. Soils & Ferts. 20(1):211. Feb. 1957.

In sand cultures with barley and soybean, N application increased (a) the intensity of photosynthesis and (b) the intensity of respiration. Potash deficiency markedly decreased (b). Increasing K supply up to one level of Hellreigel's mixture hastened the oxidizing decomposition of carbohydrates. Further increase of K slightly decreased the rate of respiration. Increasing the K supply increased the ratio (a) : (b).

A prominent businessman was asked to describe an expert. "An expert," he said, "is a man wearing a tie and an important look on his face, who knows how to complicate simplicity."

• • •

The horny-handed boy had been hired to do some hauling. The job completed, he was informed that it would be necessary to submit a statement before being paid. After much study, he produced the following: "Three comes and three goes at four bits a went, $3."

• • •

Old Maid: A woman who regrets that she had so much sense when she was young.

• • •

A couple of young boys walked into the dentist's office and one faced boldly up to the dentist and said, "Doc, I want a tooth took out and I don't want no gas 'cause I'm in a hurry."

"My," said the doc, "I must say you're a brave boy. Which tooth is it?"

The little boy turned to his silent friend and said, "Show him your tooth, Albert."

• • •

After a woman has parked her car, the big problem is which of three parking meters she should put her nickel into.

Will Rogers: "There is nothing so stupid as the educated man if you get off the subject he was educated in."

• • •

After a long boring evening, the young man finally succeeded in stealing a goodnight kiss from his young lady companion.

"That's your reward for being a gentleman," the girl murmured.

"Reward?" scowled the young man. "That's just workman's compensation."

• • •

Applying for his citizenship papers, Gino was doing all right until he came to the questions about the American flag. "What is it," asked the Judge, "that you always see flying over the Courthouse?"

"Peejins!" confidently replied Gino.

• • •

The bishop had preached a fine sermon on married life and its beauties. Two old Irishwomen coming out of church were heard commenting on the sermon, " 'Tis a fine sermon his Riverence would be after giving us," said one to the other.

"It is, indade," was the quick reply, "and I wish I knew as little about the matter as he does."

• • •

Noticed—a sign in a cafe: Man wanted to wash dishes and two waitresses; frequent rest periods.

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